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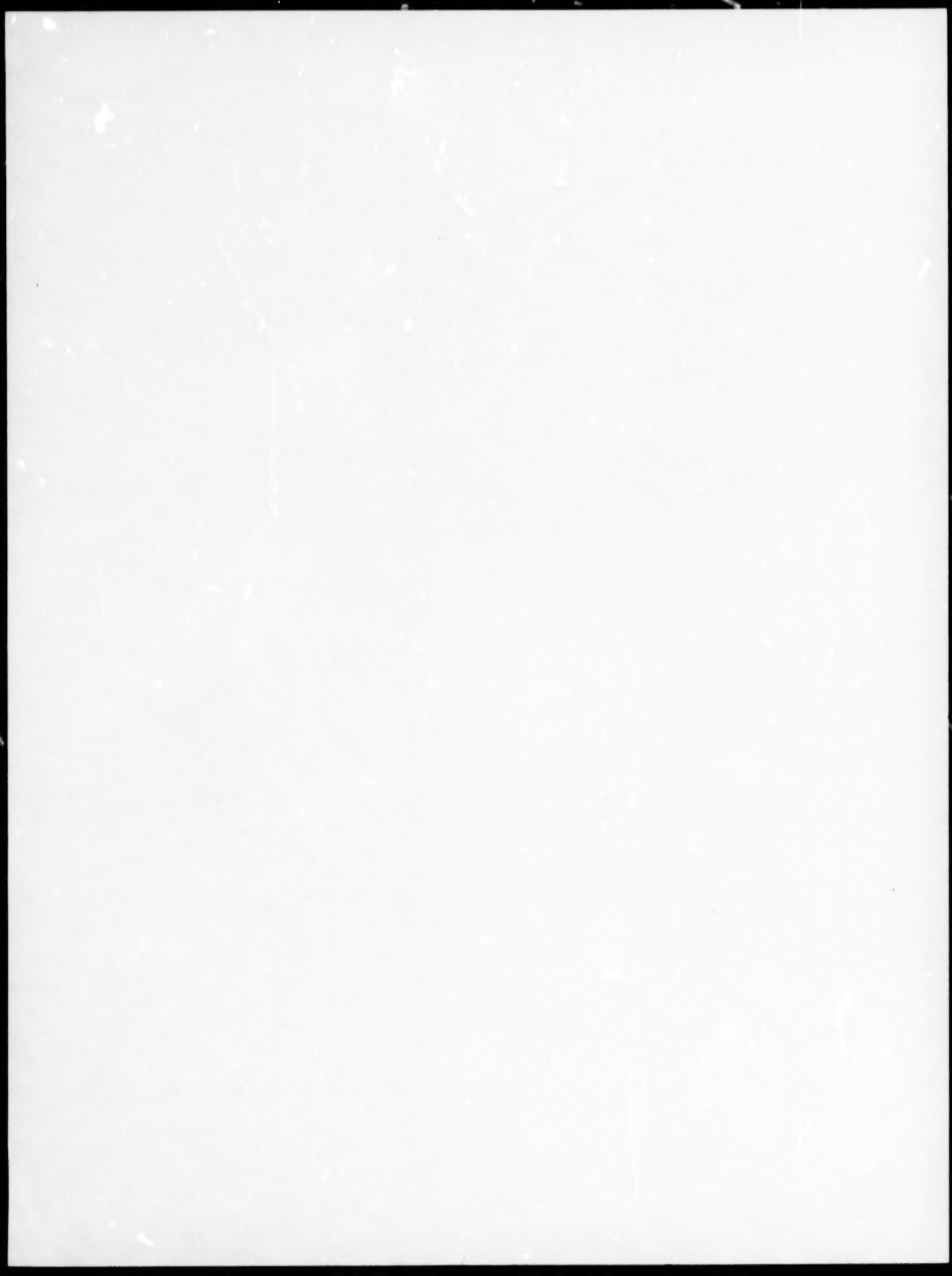
15 August, 1984

# USSR Report

PHYSICS AND MATHEMATICS



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15 August 1984

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## ACOUSTICS

### STIMULATED SCATTERING OF SOUND IN VISCOUS LIQUIDS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 86, No 1, Jan 84 (manuscript received 20 Jun 83) pp 140-146

BUNKIN, F. V., VOLYAK, K. I., LYAKHOV, G. A. and ROMANOVSKIY, M. Yu., Institute of General Physics, USSR Academy of Sciences

[Abstract] Amplification parameters are calculated for different types of stimulated scattering of sound; the conditions for the suppression of competing processes--harmonic generation, heating of the liquid and convective mixing--are assessed. The mechanisms underlying stimulated scattering of sound in the homogeneous liquids are analyzed, and the threshold scattering parameters are discussed. The parameters of nonstationary stimulated scattering of sound are calculated, and a comparative assessment of the efficiency of the processes competing with stimulated scattering is given. References 12: 11 Russian, 1 Western.  
[190-6900]

UDC 534.1

### ACOUSTIC PHENOMENA IN SYSTEMS WITH SUPERLATTICES

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84 (manuscript received 5 Mar 83, revised 22 Jul 83) pp 126-131

IOFFE, I. V.

[Abstract] Some acoustic properties of so-called superlattices, e.g., films containing magnetic bubbles--semiconductors in which additional periodicity is formed in one direction, are examined. Acoustic solitons are demonstrated to exist. The properties of an ordinary lattice in semiconductors with superlattices are examined with respect to the possibility of existence of a soliton in such a system; it is shown that oscillations can be excited in a superlattice by an ordinary acoustic wave. The low-temperature characteristics of the film heat conductance are examined. Allowance is made for friction between the lattice and superlattice. References 18: 11 Russian, 7 Western.  
[155-6900]

## EXCITATION OF SOUND BY LIGHT

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 274, No 2, Jan 84  
(manuscript received 21 Feb 83) pp 308-311

GEL'MUKHANOV, F. Kh., Institute of Automation and Electrometry, Siberian  
Department, USSR Academy of Sciences

[Abstract] A fundamentally different sound generation mechanism is examined in which the acoustic energy is "pumped" out of the thermal energy of gas. The phenomenon of light-induced drift is studied through the interaction of light with a two-component gas mixture, one component of which absorbs light, and the other of which serves as a buffer and does not interact with the light. The case in which the gas is enclosed in a cylindrical cavity and the radiation distributed uniformly over the cross-section is examined. There is no change in the total energy for a gas pulse if the optical pressure and interaction between the gas and the cell walls are disregarded and if the collisions between particles are assumed to be elastic. References 9: 8 Russian, 1 Western. [222-6900]

UDC 534.546.3

## ELECTROMAGNETIC EXCITATION OF SOUND IN METALS

Moscow USPEKHI FIZICHESKIKH NAUK in Russian Vol 141, No 3, Nov 83 pp 431-467

VASIL'YEV, A. N. and GAYDUKOV, Yu. P., Moscow State University imeni M. V. Lomonosov

[Abstract] The authors consider excitation of acoustic vibrations in a metal by an electromagnetic wave incident on its surface. An analysis is made of various mechanisms of contactless conversion in the limit of local and conductivity and under conditions of the anomalous skin effect. It is shown that, in a sufficiently strong magnetic field where the cyclotron radius of the electron orbit is shorter than the wavelength of sound, induction interaction makes a major contribution to the transformation process. In the absence of a constant magnetic field, dynamic equilibrium between the forces acting on the part of the electrons and on the part of the external field may be disturbed when electrons are scattered by the metal interface. The excitation mechanism due to diffuse scattering of electrons by the surface becomes significant on microwave frequencies. Distinguishing features of electromagnetic excitation of sound are determined for semimetals, superconductors and ferromagnetics. The ratio of the strain potential tensor to the Fermi energy is larger in semimetals than in normal metals, enhancing the role of forces that act on the lattice due to electrons that are thrown out of equilibrium. Noncontact excitation of sound provides a technique for acoustic nuclear magnetic resonance, and can be used to study a variety of interactions

of collective excitations in metals with sound waves. This applies both to the study of geometric and cyclotron resonances with electromagnetic excitation of sound, and to the problem of studying helicon-phonon and Doppler-phonon resonances and interaction with collective modes in ferromagnetics. Figures 26; references 138: 58 Russian, 80 Western.  
[195-6610]



UDC 537.531+535.3

INFLUENCE OF APPLICATION CONDITIONS OF DIELECTRIC LAYERS ON SURFACE COMPOSITION OF GALLIUM ARSENIDE

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR: SERIYA Z, FIZIKI-MATEMATICHESKIY I TEKHNIЧЕСKIY NAUKI in Russian No 11, Nov 83 (manuscript received 15 Jul 83) pp 54-56

ALESHIN, V. G., Ukrainian SSR Academy of Sciences academician, NEMOSHKALENKO, V. V., SEMASHKO, Ye. M. and SENKEVICH, A. I., Institute of Metal Physics, Ukrainian SSR Academy of Sciences

[Abstract] The influence of the applications conditions of silicon dioxide films on the surface composition of gallium arsenide is studied by X-ray photoelectronic spectroscopy. The composition of the surface layer of gallium arsenide was determined after etching the  $\text{SiO}_2$  film. The influence of the dielectric on the electrical characteristics of the metal-semiconductor interface was assessed by fashioning diode structures photolithographically. When the silicon dioxide is applied by electron-beam evaporation of quartz, the surface layer composition changes less than with high frequency sputtering, but the layer of the semiconductor in which the changes occur is thicker. The disturbances which occur in the surface layer of the gallium arsenide as dielectric layers are being applied are shown to be determined by the manner in which the condensate interacts with the substrate. Electron beam evaporation of the quartz entails significantly smaller changes in the composition of the gallium arsenide surface layer. Figure 1, references 7: 5 Russian, 2 Western. [256-6900]

## HIGH-TEMPERATURE HIGH-POWER GALLIUM ARSENIDE DEVICES

Tallin IZVESTIYA AKADEMII NAUK ESTONSKOY SSR: FIZIKA MATEMATIKA in Russian  
Vol 33, No 1, Jan-Mar 84 pp 67-76

ASHKINAZI, G., ZOLOTAREVSKIY L., TIMOFEYEV, V., MAZO, L., SHUL'GA, M.,  
VOUTOVICH, A. V., TAGASAAR, M., ORENSHTEUN, I., YUURIKI, Kh., CHELNOKOV, V.,  
Scientific Research Institute, Tallin Electrotechnical Plant imeni M. I.  
Kallinen

[Abstract] The basic parameters and characteristics of prototype gallium arsenide diodes and thyristors and the findings of investigations on the development of Schottky diodes are presented. The results of investigations of the diffusion length of electrons in undoped P-gallium arsenide formed by growing undoped layers on substrates with either conductivity type are discussed. The results of investigations into the cause of the formation of a P-region when undoped layers of gallium arsenide are grown from solution are also examined. Figures 8, references 20: 15 Russian, 5 Western.  
[244-6900]

UDC 621.382

## TRANSIENTS IN GALLIUM-ARSENIDE BASED POWER DIODES

Tallin IZVESTIYA AKADEMII NAUK ESTONSKOY SSR: FIZIKA MATEMATIKA in Russian  
Vol 33, No 1, Jan-Mar 84 pp 77-86

ASHKINAZI, G., KORSMIK, V., LOGUSOV, A., RABKIN, P., TIMOFEYEV, V.,  
SHABANOV, S. and SHUMILIN, V., Scientific Research Institute, Tallin Electro-  
technical Plant imeni M. I. Kallinen

[Abstract] The transients and frequency load characteristics of gallium arsenide power diodes are analyzed quantitatively and experimentally. A mathematical model of the achievement of the steady state in gallium arsenide power diodes is constructed. The transitional process of reverse recovery and frequency properties of gallium arsenide power diodes are investigated and modeled mathematically. The limiting load capacity of gallium arsenide power diodes operating at 66 kHz is no lower than nominal at 50 Hz; this parameter of high-frequency silicon diodes at 50 kHz is no more than 25% of the nominal value at 50 Hz (depending upon the reverse voltage being switched). Figures 6, references 12: 11 Russian, 1 Western.  
[244-6900]

INVESTIGATION OF INTERACTION BETWEEN GALLIUM ARSENIDE AND ORGANOSILICATE COATINGS AND INFLUENCE OF LATTER ON REVERSE CURVE OF CURRENT-VOLTAGE CHARACTERISTICS OF POWER DIODES

Tallin IZVESTIYA AKADEMII NAUK ESTONSKOY SSR: FIZIKA MATEMATIKA in Russian Vol 33, No 1, Jan-Mar 84 pp 57-66

ASHKINAZI, G., ZOLOTAREVSKAYA, O., MAZO, L., PAD'YUS, A., STEPANOV, K., SYRKINA, M.

[Abstract] This study presents work on the thermal and electrophysical properties of polymethylphenylsiloxane-silicate-oxide coatings in order to ensure stable operation of gallium arsenide-based power devices. No interaction takes place between gallium arsenide and the coating components at the diode is working temperature. The reverse curve of the current-voltage characteristic and the stability of gallium arsenide diodes coated with various coatings are investigated. Coatings based on BHT-45/8 and "lestosil" are shown to be most promising for protecting power devices: these ensure low reverse currents and stable long-term operation. Figures 8, references 10: 8 Russian, 2 Western.

[244-6900]

QUANTITATIVE X-RAY SPECTRAL MICROANALYSIS OF SEMICONDUCTING SOLID  $\text{AlGaAsSb}$  ( $\text{AlGaSb}$ ) SOLUTIONS

Tallin IZVESTIYA AKADEMII NAUK ESTONSKOY SSR: FIZIKA MATEMATIKA in Russian Vol 33, No 1, Jan-Mar 84 pp 14-34

AARIK, Ya., BERGMANN, Ya., KELLE, KEL'GI, LYIK, P., SAMMELSEL'G, V. and FRIDENTAL, Ya., Institute of Physics, Estonian SSR Academy of Sciences

[Abstract] Problems of the methodology of quantitative X-ray microanalysis of solid solutions of  $\text{AlGa}_{1-x}\text{AsSb}_{1-y}$  ( $\text{AlGa}_{1-x}\text{Sb}$ ) are investigated. The possibility of improving the spatial resolution of quantitative x-ray microanalysis of heterostructures by convolution is investigated. The accuracy requirements for quantitative x-ray microanalysis are derived, and statistical accuracy in determining the compositions of solid solutions is analyzed. The approaches for determining the spatial resolution of x-ray microanalysis, determining the dead time of the counting circuit and finding element concentrations are discussed. Figures 8, references 29: 17 Russian, 12 Western.

[244-6900]

## SOME PROBLEMS OF LIQUID EPITAXY OF AlGaSb and AlGaAsSb

Tallin IZVESTIYA AKADEMII NAUK ESTONSKOY SSR: FIZIKI MATEMATIKA in Russian  
Vol 33, No 1, Jan-Mar 84 pp 1-13

AARIK, Ya., BERGMANN, Ya., DOLGINOV, L., DRUZHININA, L., LYUK, P.,  
MIL'VIDSKIY, M., SAMMELSEL'G, V., FRIDENTAL, Ya., KHANSEN, K. and YUGOVA, T.,  
Institute of Physics, Estonian SSR Academy of Sciences

[Abstract] Critical supercooling of liquid phases in GaSb-AlGaSb and GaSb-AlGaAsSb systems is determined as a function of the composition of the melt, the cooling rate and the temperature under which the epitaxy is done. The solubility of arsenic in an Al-Ga-As-Sb system is investigated, and aspects of defect formation in GaSb-AlGaSb and GaSb-AlGaAsSb systems are discussed. Epitaxy performed at 570°C with arsenic added to the melt makes it possible to produce unstressed defect-free heterojunctions from  $\text{GaSb-Al}_x\text{Ga}_{1-x}\text{As}_y\text{Sb}_{1-y}$  at  $x < 0.35$ . Figures 11, references 26: 7 Russian, 19 Western.  
[244-6900]

DISRUPTION OF PSEUDOMORPHIC STATE IN  $\text{Ga}_{1-x}\text{Al}_x\text{P/GaP}$  STRUCTURES

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 3,  
12 Feb 84 (manuscript received 13 Dec 83) pp 149-153

BESSOLOV, V. N., KONINKOV, S. G., LEBEDEV, M. V., UMANSKIY, V. Ye. and  
YAKOVLEV, Yu. P., Physical-Technical Institute imeni A. F. Ioffe, USSR  
Academy of Sciences

[Abstract] The critical thickness of the pseudomorphic layer is determined experimentally as a function of the degree of nonconformity at the heteroboundary (of the solid solution). The  $\text{Ga}_{1-x}\text{Al}_x\text{P/GaP}$  system, which is promising for ultraviolet optoelectronics, is used as an example. The experimental findings are compared with calculations according to the Van der Merve theory, and are found to be close. References 7: 4 Russian, 3 Western.  
[198-6900]

## TUNNELING CHARACTERISTICS IN GaAs-BASED SYSTEM AT HIGH PRESSURES

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 86,  
No 1, Jan 84 (manuscript received 21 Jun 83) pp 381-384

VORONOVSKIY, A. N., DIZHUR, Ye. M. and ITSKEVICH, Ye. S., Institute of High  
Pressure Physics, USSR Academy of Sciences

[Abstract] Anomalous behavior of the current-voltage characteristics of  
GaAs-based tunnel diodes was detected during an investigation of the influence

of pressure on the tunneling characteristics of p-n junctions: the differential conductivity (the initial slope of the characteristic) is not single-valued at pressures of 1.5-2.8 GPa. Possible mechanisms to explain this behavior are explored. It is proposed that the existence of two states, probably due to the occurrence of traps, as well as the correlation between the anomalous behavior of current-voltage characteristics and rearranging of the electron structure of the semiconductor, may be associated with selectivity of trap processes with respect to the mobility of carriers belonging to different sub-bands. Figures 2, references 4: 1 Russian, 3 Western.  
[190-6900]

#### METAL-INSULATOR TRANSITION IN DISORDERED SYSTEM

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 86, No 1, Jan 84 (manuscript received 21 Jun 83) pp 367-380

FINKEL'SHTEYN, A. M., Institute of Theoretical Physics imeni L. G. Landau, USSR Academy of Sciences

[Abstract] The conductivity, permittivity and single-particle state density in the vicinity of metal-insulator transitions in a magnetic field or in the presence of magnetic impurities are examined. The effective free energy functional of interacting electrons in a disordered system is given. Einstein's formula is discussed, and it is demonstrated that the equations must include the charge renormalization group  $z$  in order for the equations to be consistent with the condition that the number of particles be preserved. The frequency and temperature behavior of the conductivity and permittivity are found in the critical transition region. The findings are compared with McMillan's theory. Figures 8, references 25: 6 Russian, 19 Western.  
[190-6900]

#### INFLUENCE OF EXCITON MOVEMENT IN MAGNETIC FIELD ON LUMINESCENCE. INDIRECT FORBIDDEN TRANSITIONS IN Ge

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 86, No 1, Jan 84 (manuscript received 6 Jun 83) pp 338-342

KULAKOVSKIY, V. D. and EDEL'SHTEYN, V. M., Institute of Solid State Physics, USSR Academy of Sciences

[Abstract2] The band structural characteristics of Ge are exploited in order to create an experimental situation in which the free nature of exciton movement is manifested most fully. The ratio of the integral intensities of radiation free excitons in forbidden and allowed components are compared experimentally and analytically as a function of the magnetic field; the ratio is shown to increase as the magnetic field becomes stronger. Figures 2, references 13: 5 Russian, 8 Western.  
[190-6900]



# CHARACTERISTICS OF TWO- PHONON RESONANT RAMAN SCATTERING OF LIGHT IN POLAR SEMICONDUCTORS IN STRONG MAGNETIC FIELD

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 86, No 1, Jan 84 (manuscript received 27 May 83) pp 272-286

BELITSKIY, V. I., GOL'TSEV, A. V., LANG, I. G. and PAVLOV, S. T., Physical-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] The contribution of processes involving free electron-hole pairs in a strong magnetic field through the cross section of second-order resonant Raman scattering of light is investigated. An expression is derived for the cross-section of the two-phonon scattering process in an arbitrarily strong magnetic field. It is demonstrated that the scattering cross-section is of the first order with respect to the Froelich coupling constant  $\alpha$  for an Nth order ( $N > 2$ ) many-phonon resonant Raman scattering process. A qualitative explanation is provided for the fact that  $\alpha$  is of lower degree than for magnetic field levels of zero. Interference contributions to the scattering cross-section, which become significant close to a discrete set of values of a strong magnetic field, are analyzed. Figures 4, references 15: 9 Russian, 6 Western.

[190-6900]

# PHASE CONJUGATION BY SEMICONDUCTOR SURFACE IN PLASMA REFLECTION

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 86, No 1, Jan 84 (manuscript received 18 May 83) pp 232-241

MAMAYEV, A. V., MEL'NIKOV, N. A., PILIPETSKIY, N. F., SUDARKIN, A. N. and SHKUNOV, V. V., Institute of Problems and Mechanics, USSR Academy of Sciences

[Abstract] Phase-conjugate reflection by surfaces of various semiconductors (Ge, GaAs, InSb, Si) with an efficiency of up to 7% is obtained experimentally. A theoretical model for recording surface homograms based on a plasma reflection mechanism is proposed. The theoretical findings are reasonably consistent with the experimental data. Phase conjugation by semiconductors can be employed in the long-wave region of the spectrum. The surface nonlinearity mechanism is reversible and has low inertia. Figures 6, references 24: 18 Russian, 6 Western.

[190-6900]



## ELECTROMAGNETIC EFFECTS IN STRONG FIELD OF SINGLE CRYSTALS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 86, No 1, Jan 84 (manuscript received 7 Jun 83) pp 94-99

LASUKOV, V. V., and VOROB'YEV, S. A., Tomsk Polytechnical Institute

[Abstract] The optical and electrical generation of relativistic  $e^-e^+$ -pairs is investigated for the case in which each component of the generated pair executes nonrelativistic finite movement in the transverse direction and free relativistic movement along the crystallographic axis or plane. The probability of optical generation of relativistic  $e^-e^+$ -pairs is examined in accordance with the theory of quantum transitions based on the operator method. This intermediate result is then used to find the probability of electrogeneration of  $e^-e^+$ -pairs by an ultrarelativistic electron in the presence of the irregular electrical field of a crystallographic plane. The electron pair generation process can serve as a monochromatic source of position-type relativistic pairs, as well as for investigating nonlinear quantum effects based on this process. References 8: 6 Russian, 2 Western.  
[190-6900]

UDC 535.215.5/6:539.2

## INFLUENCE OF DEEP IMPURITIES ON PHOTOELECTRIC PHENOMENA IN $Bi_{12}SiO_{20}$ CRYSTALS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84 (manuscript received 5 Jul 83, revised 31 Aug 83) pp 227-233

GRACHEV, A. I., Physical-Technical Institute imeni I. F. Ioffe, USSR Academy of Sciences

[Abstract] The participation of deep impurities in binary optical transitions is demonstrated by studying impurity photo-emf in  $Bi_{12}SiO_{20}$ . The concentration and cross-section of deep impurity photo-ionization are determined on the basis of this finding, and experimental and theoretical investigations of the transitional junction photo-current are described. It is demonstrated that a Schotky barrier forms at the junction between  $Bi_{12}SiO_{20}$  crystals and the electrode, and that deep impurities exist that are involved in binary optical transitions in the "shoulder" region of impurity absorption. Transitional photo-currents in  $Bi_{12}SiO_{20}$  are measured; a theoretical model is constructed and the findings are discussed. The critical value of the barrier electric field intensity is found to be  $(1-2) \cdot 10^6 \text{ V} \cdot \text{cm}^{-1}$ . The most probably mechanism underlying the increase in junction injection is a transition to the thermal field emission mode. Figures 4, references 20: 15 Russian, 5 Western.  
[155-6900]

## FORMATION OF MICRODEFECTS DURING GROWTH OF SILICON SINGLE CRYSTALS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 14 Feb 83, revised 22 Aug 83) pp 207-213

SHEYKHET, E. G., FAL'KEVICH, E. S., NEYMARK, K. N., CHERVONYY, I. F. and  
SHERSHEL', V. A., Zaporozh'ye Industrial Institute

[Abstract] Experimental findings on the influence that diffusion of point defects and impurities has on the process of formation and subsequent development of microdefects are presented. Electrically neutral carbon and oxygen admixtures are shown to serve as the centers for the formation of microdefects in silicon single crystals. A continuous sequence of generation, development and transition of one type of defect to another is demonstrated as a function of the growing conditions (rate of growth, temperature radiant and cooling rate). Impurity centers and high-temperature diffusion of point defects play the most important role. Figures 7, references 14: 5 Russian, 9 Western. [155-6900]

## DETECTION OF PHONON PULSES IN Ge AND Si CRYSTALS WITH FLUORESCENT CONTACT PHONON SPECTROMETER

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 11 Aug 83) pp 192-194

AKIMOV, A. V., GIL'FANOV, F. Z., KAPLYANSKIY, A. A. and KVASOV, Ye. L.,  
Physical-Technical Institute imeni I. F. Ioffe, USSR Academy of Sciences

[Abstract] A fluorescent contact phonon spectrometer is built experimentally that employs fluorescence of the dielectric film on the surface of specimens to detect non-equilibrium phonon pulses in germanium as well as silicon at several phonon frequencies. The influence of the "hot spot" on terahertz phonon generation is examined. The fluorescence pulses exhibit a steep "ballistic" leading edge; the decay of the trailing edge, which greatly exceeds the length of a laser pulse, generally agrees with the findings obtained in bolometric detection of phonon pulses excited by a 1.06  $\mu\text{m}$  laser in germanium. Figures 2, references 6: 4 Russian, 2 Western. [155-6900]

## INTERACTION OF PHONONS IN NAPHTHALENE CRYSTAL

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 3 May 83, revised 1 Aug 83) pp 164-171

KRIVENKO, T. A. and SHEKA, Ye. F., Institute of Solid State Physics, USSR  
Academy of Sciences

[Abstract] A quantitative investigation is made of the anharmonic interaction of a single internal phonon in a naphthalene crystal with an external phonon. This interaction is manifested by the occurrence of wide bands in the IR and Raman spectra corresponding to two-phonon transitions in which internal and external phonons (sum bands) are generated during the absorption (or scattering) of light. The width of the band is determined by the spectrum width of the external phonons. The intensity and form of the phonon branch are analyzed quantitatively for OCS crystals. Figures 4, references 30: 7 Russian, 23 Western.  
[155-6900]

UDC 535.33:535.312:539.238

OPTICAL PROPERTIES OF  $\text{Ga}_x\text{In}_{1-x}\text{As}_y\text{Sb}_{1-y}$ 

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 26 Jul 83) pp 145-150

BELOV, A. G., BELOGOROKHOV, A. I., BOCHKAREV, A. E., DOLGINOV, L. M.,  
DRUZHININA, L. V., ZINGER, G. M., IL'IN, M. A., KARASEV, P. Yu., MIL'VIDSKIY,  
M. G., RZAYEV, D. A. and RYSKIN, A. I.

[Abstract] The reflection spectra of epitaxial layers of a solid solution of  $\text{Ga}_x\text{In}_{1-x}\text{As}_y\text{Sb}_{1-y}$  ( $x=0.92$ ,  $y=0.07$ ) grown on a substrate of GaSb in the mid- and far-IR regions of the spectrum ( $\lambda=20-260 \mu\text{m}$ ) are examined. Because the compositions of the layer and the substrate are so similar, interference effects are determined by the difference between the concentrations of free carriers in the layer and the substrate. The carrier concentration and mobility in the layer are found by analyzing the reflection spectra of the system. The layers were grown on n-type substrates doped with Te; the layers were also doped with Te. The optical properties of the epitaxial layers, as well as reflecting spectra are described. Figures 6, references 11: 5 Russian, 6 Western.  
[155-6900]

SUPERIONIC CONDUCTIVITY OF TETRAGONAL MODIFICATION OF  $\text{ZnP}_2$  AND  $\text{CdP}_2$  SINGLE CRYSTALS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 15 Mar 83, revised 22 Jul 83) pp 132-137

NOVIKOV, V. P., SHELEG, A. U. and FILIMONOV, V. A., Institute of Solid State Physics and Semiconductors, Belorussian SSR Academy of Sciences

[Abstract] The electrical properties of  $\text{ZnP}_2$  and  $\text{CdP}_2$  are studied with respect to ion mobility. Direct current ion transfer is studied in single crystals of  $\text{ZnP}$  and  $\text{CdP}$  grown from the gaseous phase. The electrical conductivity was investigated by the impedance method at 20 Hz-30 MHz. Polarization phenomena in  $\text{CdP}_2$  were studied by measuring dielectric permeability. The nature of the superionic state in  $\text{ZnP}_2$  and  $\text{CdP}_2$  is discussed. Figures 3; references 29: 16 Russian, 13 Western.  
[155-6900]

UDC 621.315.592

## NONEQUILIBRIUM OPTICAL AND ACOUSTIC PHONONS IN SEMICONDUCTORS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 31 Jan 83, revised 22 Jul 83) pp 120-125

GUREVICH, Yu. G. and MASHKEVICH, O. L., Institute of Radiophysics and Electronics, Ukrainian SSR Academy of Sciences

[Abstract] A cubic semiconductor with one type of carrier is examined in order to derive kinetic equations for nonequilibrium electrons and optical and acoustic phonons. The two-stage acousto-optical entrainment is mutual: the thermal phonon flux depends upon the electrical and magnetic field and the temperature gradient in the electron subsystem. The applicability conditions for diffuse approximations for optical phonons are given. References 17: 15 Russian, 2 Western.  
[155-6900]

## EPR INVESTIGATION OF PROCESSES UNDERLYING OPTICAL EXCITATION AND RELAXATION OF Si-Cl-CENTERS IN IRRADIATED SILICON

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 21 Jul 83) pp 114-119

VLASENKO, L. S., ZARITSKIY, I. M., KONCHITS, A. A. and SHANIN, B. D., Institute of Semiconductors, Ukrainian SSR Academy of Sciences, and Physical-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] Transients in the EPR of Si-Sl centers are studied over a wide range of temperatures in order to explain the mechanisms that control the behavior of these systems. The measurements were made on a pulsed super-heterodyne spectrometer at temperatures ranging from 2.5 to 100 K, employing specimens of electron-irradiated n-type silicon. An excited triplet state is formed with the participation of optically excited current carriers, in contrast to the internal center excitation that occurs in a number of analogous systems. The spin states of the triplet are not in equilibrium because of the selectivity of their decay processes. The dynamic characteristics of the system are observed to be temperature-dependent up to 20 K due to the spin-relaxation mechanism of the triplet state. Figures 6, references 9: 2 Russian, 7 Western.  
[155-6900]

## WIDENING OF DIAMAGNETIC EXCITON LINE IN SOLID SOLUTIONS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 20 Jun 83) pp 106-113

RAYKH, M. E. and EFROS, Al. L., Physical-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] The influence of fluctuations in composition on the line width of a diamagnetic exciton is examined. The line width increases with the magnetic field due to an increase in the potential acting upon the exciton and an increase in its translation mass in the plane perpendicular to the magnetic field. Figures 3, references 13: 7 Russian, 6 Western.  
[155-6900]



STATISTICAL MODELING OF  $\text{Yb}^{3+}$  OPTICAL CENTERS IN GLASS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 30 Jun 83) pp 50-55

PRZHEVUSKIY, A. K.

[Abstract] The absorption and luminescence spectra of a set of  $\text{Yb}^{3+}$  centers are analyzed with the aid of a statistical model in order to describe the typical experimental spectra and to determine the size of the class of models in which the characteristics of real spectra can be obtained. An extremely narrow resonance band, which is the most typical feature of Stark spectrum structures, is not affected by the geometry of the immediate vicinity of the  $\text{Yb}^{3+}$  ion. Figures 3, references 14: 11 Russian, 3 Western.  
[155-6900]

UDC 539.143.43;539.219.3

INVESTIGATION OF ION MOVEMENT AND HIGH TEMPERATURE PHASE TRANSITION IN  $\text{NH}_4\text{HSeO}_4$  AND  $\text{RbHSeO}_4$  CRYSTALS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 29 Jun 83) pp 38-44

MOSKVICH, Yu. N., SUKHOVSKIY, A. A. and ROZANOV, O. V., Institute of Physics imeni L. V. Kirenskiy, Siberian Department, USSR Academy of Sciences

[Abstract] The temperature behavior of the nuclear magnetic resonance spectra of  $^1\text{H}$  and  $^{77}\text{Se}$  nuclei and the proton nuclear relaxation time are examined in the high-temperature regions in  $\text{NH}_4\text{HSeO}_4$  and  $\text{RbHSeO}_4$  crystals. The results of the NMR measurements are compared with conductivity data obtained for the same temperature region. The measurements were made on a JNM 3H-60 NMR spectrometer with a BL-2 attachment for wide lines; laboratory-fabricated pulsed NMR spectrometers were also employed. The frequencies and activation energies of the diffusion mobility of the protons and ammonia groups are determined. Figures 6, references 23: 11 Russian, 12 Western.  
[155-6900]

JAHN-TELLER EFFECT OF  $\text{Cu}^{2+}$  ION IN  $\text{LiNbO}_3$  SINGLE CRYSTAL

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 27 Jun 83) pp 22-28

PETROSYAN, A. K., KHACHATRYAN, R. M. and SHAROYAN, E. G., Institute of Physical Research, Armenian USSR Academy of Sciences

[Abstract] It is demonstrated on the basis of new experimental findings obtained from optical absorption and electron paramagnetic resonance spectra that they can be interpreted only when allowance is made for the Jahn-Teller effect. Investigation of the electron parametric resonance of lithium niobate disclosed a number of singularities resulting from the joint interaction of static  $E \times e$  of the Jahn-Teller effect, the trigonal field and local deformation. A band is detected in optical absorption spectra at  $5000 \text{ cm}^{-1}$  that is caused by the Jahn-Teller effect; JAHN-Teller stabilization energy of  $1250 \text{ cm}^{-1}$  is determined. Figures 8, references 22: 5 Russian, 17 Western.  
[155-6900]

PROPERTIES OF MAGNETIC SEMICONDUCTING SOLID SOLUTIONS OF  $\text{Zn}_{1-x}\text{Ga}_{2x/3}\text{Cr}_2\text{Se}_4$ 

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 26, No 1, Jan 84  
(manuscript received 6 Jun 73) pp 3-9

ZHUKOV, A. A., KESLER, Ya. A., MESHCHERYAKOV, V. F. and ROZANTSEV, A. V., Moscow Institute of Electrical Engineering, Electronics and Automation

[Abstract] The magnetic and electrical properties of the  $\text{Zn}_{1-x}\text{Ga}_{2x/3}\text{Cr}_2\text{Se}_4$  system are studied as  $x$  varies from  $x=0$  to the solubility limit of Ga  $x=0.5$ . The solid solutions were synthesized by the solid phase method in evacuated quartz ampules. All of the specimens have spinel structure in the region  $0 \leq x \leq 0.5$ . The magnetic susceptibility, conductivity, Hall coefficient and electron spin resonance were measured. The magnetization of all of the specimens varied linearly as a function of the magnetic field intensity throughout the temperature range considered. The width of the resonance line increases with the concentration of  $x$  at fixed temperatures. The analysis, which also holds for other chalcogenide spinels, indicates that the binding energy of the impurity centers is the same as the activation energy. Figures 8, references 12: 5 Russian, 7 Western.  
[155-6900]

TEMPORAL AND SPATIAL EVOLUTION OF PERIODIC STRUCTURES OCCURRING ON SURFACE  
OF LASER-IRRADIATED SOLIDS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 4 Dec 82) pp 2283-2286

KONOV, V. I., PROKHOROV, A. M., SYCHUGOV, V. A., TISHCHENKO, A. V. and  
TOKAREV, V. N., Physics Institute imeni P. N. Lebedev, USSR Academy of  
Sciences

[Abstract] A model of the lattice evolution on the surface of a semiconductor  
(metal or dielectric) irradiated by powerful laser radiation is used to extend  
qualitatively the experimental finding that the limiting diffraction efficiency  
(depth) of the lattice is a function of the intensity of the incident wave.  
Photometrographs of the surface of fused quartz taken every 30 laser pulses  
from a CO<sub>2</sub> laser provide evidence that the model is valid. Figures 2,  
references 4: 3 Russian, 1 Western.  
[146-6900]

UDC 538.614

LASER RADIATION DEFLECTOR BASED ON GARNET FILM WITH SUBMICRON DOMAINS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 25 Nov 82) pp 2278-2280

ZUBKOV, Yu. N., Kuybyshev State Pedagogical Institute imeni V. V. Kuybyshev

[Abstract] The diffraction properties of thin (1-3  $\mu$ m) garnet films and  
their ability to deflect an external magnetic field acting upon the domain  
structure in the visible portion of the spectrum are examined. A magneto-  
optical laser radiation deflector with fairly good diffraction efficiency and  
large angle of deflection is implemented. The variation of the domain  
structure period, the exit angle and the intensity of the first diffraction  
maximum under the influence of a magnetic field are shown. The implementation  
of a two-dimensional magneto-optical deflector requires that the magnetic  
field be applied in two perpendicular directions. Figures 2, references 5:  
3 Russian, 2 Western.  
[146-6900]

INVESTIGATION OF CAPILLARY EFFECT IN Ga-Al-As/GaAs SYSTEM

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 30 Jan 83) pp 2224-2226

ABDURAKHMANOV, Yu. Yu., BARANOV, A. N. and YAKOVLEV, Yu. P., Physical-Technical  
Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] The boundary wetting angle and surface tension coefficient are  
studied for a Ga-Al-As/GaAs system directly within a capillary formed by sub-  
strates of GaAs for the temperature range and compositions employed in capillary  
liquid epitaxy. Figures 2, references 5: 4 Russian, 1 Western.  
[146-6900]

COOPERATIVE EFFECTS IN YEAG (YAG:Er<sup>3+</sup>) CRYSTALS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 13 May 83) pp 189-192

ZHEKOV, V. I., LOBACHEV, V. A., MURINA, T. M. and PROKHOROV, A. M., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Cooperative mechanisms in YEAG (yttrium-erbium-aluminum garnet) crystals, with ion-ion interaction and shifting of electron excitation energy from the lower laser level to the higher laser level through the resonance level, are analyzed on the basis of data pertaining to the kinetics of luminescence ( $\lambda \approx 1 \mu\text{m}$ ) at levels of the active  $^4I_{11/2} - ^4I_{15/2}$  transition of the Er<sup>3+</sup> ion. In the experiment such crystals were excited by radiation from an argon laser ( $\lambda = 488.0 \text{ nm}$ ), with this radiation being chopped into pulses with a low repetition density of 1:10 by means of a rotating shutter with wide speed control. Comparative evaluation of experimental data and the steady-state solution of kinetic equations describing population changes at levels  $^4I_{11/2}$  and  $^4I_{13/2}$  for various Er<sup>3+</sup> ion concentrations reveals a 1.5% luminescence quantum yield at the  $^4I_{11/2}$  level in the YAG:Er<sup>3+</sup> crystal and the possibility of increasing the efficiency of cooperative processes, quenching the luminescent  $^4S_{3/2}$  state through cross-relaxation while boosting the population of the  $^4I_{13/2}$  state, by increasing the Er<sup>3+</sup> ion concentration to high levels. They also reveal high metastability of the  $^4I_{13/2}$  state, at which the electron excitation energy builds up, and cooperative effects developing near the threshold pumping level, Stark splitting of the  $^4I_{13/2}$  multiplet, and exact resonance of transitions  $^4I_{13/2} - ^4I_{9/2}$ ,  $^4I_{13/2} - ^4I_{9/2}$  with narrow  $^4I_{9/2} - ^4I_{11/2}$  energy gap and strong electron-phonon interaction facilitating rapid departure from resonance and thus preventing reverse energy transfer. Figures 3, table 1, references 7: 5 Russian, 2 Western.  
[166-2415]

UDC 621.315.592

## FORMATION AND ANNEALING OF DEEP DONOR LEVELS WITH ELECTRON IRRADIATION OF GALLIUM ARSENIDE

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR: SERIYA FIZICHESKIKH I  
TEKHNICHESKIKH NAUK in Russian No 1, Jan-Feb 84 (manuscript received 6 Jun 83)  
pp 28-35

KIRSON, Ya. E., KLOTYN'SH, E. E., KRUMINYA, R. K. and ULMANIS, U. A., Power Engineering Physics Institute LaSSR Academy of Sciences

[Abstract] An examination is made of the influence that bombardment by electrons with energy of 3.5 MeV and fluence up to  $2 \cdot 10^{17} \text{ cm}^{-2}$  has on the electrical conductivity, Hall effect and charge carrier mobility of tellurium-doped gallium



arsenide. Initial parameters of the specimens at 300 K: electron concentration  $2.5 \cdot 10^{17} - 3.2 \cdot 10^{18} \text{ cm}^{-3}$ , mobility  $1700 - 4030 \text{ cm}^2/\text{V s}$ . The temperature of the specimens during exposure did not exceed  $50^\circ\text{C}$ . It is found that irradiation brings the electron concentration to  $8.5 \cdot 10^{17} \text{ cm}^{-3}$  and produces deep donors. Theoretical analysis of the temperature dependences of the Hall factor with consideration of the actual experimental conditions after irradiation and subsequent annealing of defects showed that, after irradiation with fluence up to  $1 \cdot 10^{17} \text{ cm}^{-2}$ , experimental data up to annealing temperatures of  $195^\circ\text{C}$  are basically in agreement with the model of a partly compensated local level where the electron concentration up to 400 K is much lower than the concentration of compensating activators. Possible numerical values of donor activation energy are 0.071, 0.089, 0.15, 0.16, 0.27 and 0.35 eV. When combined with data from the literature (0.080, 0.12, 0.13, 0.17, 0.20, 0.31 and 0.38 eV), these form a quasi-continuous series of donor activation energies in gallium arsenide. Figures 3, tables 2, references 7.  
[202-6610]

UDC 537.311.33:539.16

#### STRUCTURAL STUDIES OF NEUTRON-IRRADIATED GALLIUM ARSENIDE

Tbilisi SOOBASHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 3, No 2, Aug 83 (manuscript received 25 Jun 82) pp 273-276

BARAMIDZE, M. V., KURDIANI, N. I. and KUTELIYA, E. R., Tbilisi State University

[Abstract] The structure of radiation defects formed by fast neutrons in semiconductors and semiconductor devices predetermines the behavior of physical properties of irradiated specimens. It has been suggested that disordered regions in  $\text{A}^3\text{B}^5$  semiconductors are inclusions of amorphous material. Ion bombardment of semiconductors also leads to amorphization of the specimen. In this paper, the authors study the structural differences of defects formed by these two kinds of irradiation. Gallium arsenide single crystals with electron concentration at room temperature of  $3 \cdot 10^{16}$  and  $10^{17} \text{ cm}^{-3}$  were irradiated with fast-reactor neutrons in doses of  $2 \cdot 10^{17}$  and  $5 \cdot 10^{15} \text{ n/cm}^2$ . Analysis of electron diffraction patterns showed that the thermodynamically stable disordered region in neutron-irradiated GaAs is probably an amorphized region consisting of individual crystal cells with dimensions of the same order of magnitude as the lattice constant in random mutual orientation. This structure distinguished the disordered regions from layers of total amorphization produced by ion bombardment, which apparently lack short-range correlation. Figures 2, references 5.  
[136-6610]



## DETERMINING GROUP VELOCITY OF POLARITONS IN GALLIUM PHOSPHIDE CRYSTALS BY RAMAN LIGHT SCATTERING METHOD

Dushanbe IZVESTIYA AKADEMII NAUK TADZHIKSKOY SSR: OTDELENIYE FIZIKO-MATEMATICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian Vol 88, No 2, Apr-Jun 83 (manuscript received 13 Nov 81) pp 71-75

GORELIK, V. S., UMAROV, B. S. and KHASHIMOV, R. N., Physicotechnical Institute imeni S. U. Umarov, TaSSR Academy of Sciences

[Abstract] Raman scattering of light has been used in previous research for studying the characteristics of polariton excitations in nonlinear crystals as a basis for development of paramagnetic generators, laser frequency converters and other quantum-electronics devices. The main thrust of this work was to study the polariton dispersion law. In this paper, the authors develop a direct method of determining group velocity of polaritons, and of establishing the relation between group velocity and wave vector from Raman scattering experiments. The theory is based on analyzing the wave vector as a function of the frequency of transverse optical oscillations in an approximation of plane monochromatic waves. In the experiments, a laser beam was focused at different angles of incidence on a plane-parallel gallium phosphite plate, and the exit beam was sent to a monochromator. The output signal was picked up by a photomultiplier, amplified and recorded by a potentiometer. Polariton spectra are given for different angles of incidence. These spectra are used for measuring the half-width of the polariton line of Raman scattering, group velocities and their dispersion dependences in this crystal. The results show good agreement with theory up to wave vectors of about  $14,000 \text{ cm}^{-1}$ . Figures 5, references 4: 2 Russian, 2 Western.  
[109-6610]

UDC 621.372.2

INVESTIGATION OF STATISTICAL CHARACTERISTICS OF RANDOM SIGNALS IN NONLINEAR MEDIUM

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 3 FIZIKA ASTRONOMIYA in Russian Vol 25, No 1, Jan-Feb 84 (manuscript received 1 Jul 83) pp 103-105

GORSHKOV, A. S., LYASHED'KO, L. G. and TROFIMENKO, I. T., Department of Microwave Radio Physics

[Abstract] The distribution function of narrowband noise in a nonlinear distributed transmission line with weak dispersion is investigated experimentally. An expression for the distribution function is derived that allows for quadratic and cubic nonlinearity and frequency-independent losses. The nonlinear weakly dispersing medium was modeled by a low-pass filter with varicaps serving as nonlinear capacitances. Cubic nonlinearity of the medium results in an asymmetry of the distribution function for positive and negative noise voltage values. References 6 Russian.  
[193-6900]

UDC 538.566.5

ABSORPTION OF PULSE PROPAGATING IN WAVEGUIDE

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83 (manuscript received 7 Dec 82) pp 2178-2182

ZAYKO, Yu. N.

[Abstract] The distortion of pulse propagating in a waveguide due to wall absorption is examined. Square and type  $H_{10}$  waves are considered, the findings are extended to include other types of waves and round waveguides. The relationships derived are valid for any absorbing-dispersing medium. An ALGOL program was written to analyze the propagation of a square-wave pulse in a waveguide with allowance for wall absorption. Figures 2, references 9 Russian.  
[146-6900]

## TRANSFORMATION OF HETEROGENEOUS SURFACE WAVES BY TAPERED SCREENS

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR: SERIYA A, FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 3, Mar 84 pp 48-52

YEVDOKIMOV, A. P.

[Abstract] Scattered electromagnetic fields resulting from the interaction of the surface wave in a flat dielectric waveguide with periodic structure consisting of a tapered reflecting array are investigated. The electrodynamic structure consists of a nonuniform plane wave source provided by a flat dielectric waveguide lying in plane  $yoz$  with an E-type wave propagating along the  $oz$  axis. The possibility of controlling the direction of propagation of surface and volume diffraction waves is demonstrated. References 2 Russian. [255-6900]

## SOLITON MODE OF SPIN DIFFUSION IN BISTABLE STATE

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 39, No 1, 10 Jan 84 (manuscript received 8 Oct 83) pp 5-8

TEYTEL'BAUM, G. B., Kazan PHYSICOTECHNICAL Institute, USSR Academy of Sciences

[Abstract] Two stable steady states with different magnetization are possible in paramagnetic spin systems with an S-shaped characteristic curve for the amplitude of rf magnetization versus the rf field strength. Such behavior is typical of nuclear spin systems with dynamic NMR frequency shift. Based on the example of such systems, the author shows how magnetization flips from one state to the other under conditions of nonlinear spin diffusion. Nuclear spins are considered in which the NMR frequency shift is due to indirect action via electron spins. The results of the analysis show that propagation of a soliton-like magnetization front gives rise to the change from one steady state of magnetization to the other. This switch of nuclear magnetization state can be accomplished by changing the rf pumping power or the frequency mismatch. Such states are frequency-spaced by a distance that appreciably exceeds the width of the resonance line. Therefore the time change in relative intensity of the corresponding NMR signals that is characteristic of the displacement of the front can be observed when a weak auxiliary field passes through NMR. Another method of observation may be to study displacement of the antiferromagnetic resonance frequency. The formation of solitons of this kind in a medium that is spatially homogeneous in the absence of rf pumping is typical of any paramagnetic systems with S-shaped characteristic curve. Figure 1, references 7: 4 Russian, 3 Western. [132-6610]

UDC 5393:533.601.342

OSCILLATIONS OF ELASTIC AIRPLANE DUE TO WIND GUST

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKhanika,  
ASTRONOMIYA in Russian No 1, Jan 84 (manuscript received 24 Jun 83)

IVANOVA, A. V.

[Abstract] The problem is considered of determining the reaction of a swept-back wing aircraft at constant speed to a single gust of wind with arbitrary speed distribution. The wing is considered a thin and elastic bar, and the fuselage as a heavy body capable of vertical movement and rotation around the center of gravity. Symmetrical oscillations are considered. A set of differential equations is developed describing combined flexional-torsional oscillations of a thin-walled bar taking into account the transverse cross-section deformation and displacement. There are boundary conditions for the free end of the bar and for the union of wing and fuselage. The introduction of a dimensionless time factor and an aerodynamic load expression leads to the final form of the equations for which specific gust conditions must be chosen. References 3 Russian.  
[164-12497]

UDC 533.601.155

SUPERSONIC NONSTEADY FLOW PAST FLAT AND AXISYMMETRIC POINTED BODIES

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKhanika,  
ASTRONOMIYA in Russian No 1, Jan 84 (manuscript received 10 Jun 82) pp 80-83

POTEKHINA, Ye. A.

[Abstract] The problem of the movement of a flat or axisymmetric sharp body with a curvilinear generatrix in a quiescent gas at supersonic speed is considered. Using Lagrange variables, a system of equations is formulated and integrated to determine the parameters of the gas flow in the shock wave between the front of the shock wave and the surface of the body. The solution involves the fact that the sojourn time of gas particles in the shock wave can be considered small and parameter values fall as the speed of motion of the

body increases. Comparison of the approximation estimate with the result of the characteristic method computations ( $M = \infty$ ) yielded an error of less than 7% and with experimental data ( $M = 2.3$ ) showed an error of the order of 13%. Effectiveness was, however, computed for a steady-state example which is least suitable for the method that operates best for nonsteady flow. Figure 1, references 4: 3 Russian, 1 Western.  
[164-12497]

UDC 533.6.011

#### SUPERSONIC JET-CAVITY INTERACTION PULSATION

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKhanika, ASTRONOMIYA in Russian No 1, Jan 84, pp 64-68

KOTOV, A. I. and UGRYUMOV, Ye. A.

[Abstract] Jet-cavity pulse interaction has been studied theoretically and experimentally; recently numerical methods have been applied with modeling of the pulse mode during supersonic inflow, and the present numerical study gives the results for the case of low-frequency oscillations. The Godunov method was used in an axisymmetric two-dimensional non-stationary formulation. The jet formation for assigned boundary and limiting conditions and the development of oscillatory flow modes were studied for various geometrical and gas dynamic parameters. Pressure variations computed as a function of jet Mach numbers agree with the results from formulas and also correspond to experimental values if adjustments are made in cavity diameter and the location of the sensor. Numerical results apply valuable qualitative and quantitative data on flow variation and are a significant addition to analytic and experimental methods. Figures 5, references 6 Russian.  
[164-12497]

UDC 556.535.2

#### EXPERIMENTAL RESEARCH ON TRANSVERSE FLUID CIRCULATION IN SHORE REGION OF TURBULENT CHANNEL FLOW

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 3 FIZIKA ASTRONOMIYA in Russian Vol 24, No 4, Jul-Aug 83 (manuscript received 1 Feb 83) pp 82-84

MEL'NIKOVA, O. N.

[Abstract] On the boundary layers of turbulent flows, secondary flows arise with directions different from the main flow due to anisotropic pulsation characteristics of the force field in the flow boundaries. The research has practical applications for real channel flows, and the study involved three-dimensional modeling of a turbulent channel with a length of 1 m, depth of 10 cm and flow of 76 cm/s. Flow velocity was measured with a Pitot tube, and



a complex thermohydrometer measured translation angles of flow vectors so that it was possible to establish the vector field at various points in the current. It was found that there was no circulatory movement in the flow center. Thermohydrometer and Pitot measurements in the transverse section determined the three components of the average speed vector and established the existence of a vertical circulatory movement at the channel boundaries where the fluid circulates vertically from bottom to top. Fundamental flow characteristics and values were obtained. Figures 2, references 3: 2 Russian, 1 Western. [165-12497]

UDC 517.9:532.5

#### APPROXIMATE DETERMINATION OF DISTANCE TO INSTANTANEOUS POINT SOURCE IN VISCOUS COMPRESSIBLE FLUID

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 3 FIZIKA ASTRONOMIYA in Russian Vol 24, No 4, Jul-Aug 83 (manuscript received 16 Jun 82) pp 15-18

SHATOV, A. K.

[Abstract] The pressure field created by a small pressure disturbance due to the action of an instantaneous point source is described by equations that are simplified by asymptotic reductions also allowing a supposition as to the location of the signal receiver. The derived equation approximately describes a radially symmetric pressure disturbance propagating from the coordinate origin, and the disturbance profile resembles a gaussian curve that degenerates with time and the top of which shifts with the unit speed vector. This characteristic makes it possible to determine the distance from receptor to source. Amplitude is also determined, and if there are reflections in addition to the point source and the receiver in the medium that are not on the line connecting them, distortion occurs and a computation method for this is also given. References 4 Russian. [165-12497]

#### THEORY OF OCCURRENCE OF LARGE-SCALE STRUCTURES IN DYNAMIC TURBULENCE

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 85, No 6(12), Dec 83 (manuscript received 24 Nov 82, revised 8 Jul 83) pp 1979-1987

MOUSEYEV, S. S., SAGDEYEV, R. Z., TUR, A. V., KHOMENKO, G. A. and YANOVSKIY, V. V., Institute of Space Research

[Abstract] The formally simple case in which the random field of turbulent velocity fluctuations can be assumed to be gaussian is examined. The gyrotropic hydrodynamic turbulence is shown to increase eddy perturbations, resulting near where large-scale structures occur. The structures themselves are shown to be gyrotropic; the development of instability is accompanied by the transfer of

energy from small scales to large. Amplification of coherent structure is shown to occur due solely to a reflecting invariance of the turbulence. It is demonstrated possible to derive closed averaged motion equations for the non-gaussian case as well. References 15: 11 Russian, 4 Western.  
[189-6900]

UDC 517.958:533.6.011

#### RADIANT HEAT EXCHANGE IN SHOCK LAYER DURING SPATIAL FLOW ABOUT FRUSTRA

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 24, No 3, Mar 84 (manuscript received 21 Nov 82; revised 22 Mar 83)  
pp 435-441

KOSTUZIK, A. A. and RUMYNSKIY, A. N.

[Abstract] Spherical, segmented and segmented conical frustra in a flow of non-viscous non-heat conducting selectively radiating and absorbing gas are studied. Absorption and radiation in strong atomic lines are disregarded. The transfer of radiant energy in the shock layer in the absence of scattering is examined. The error in the determination of the radiant thermal flux toward the surface of the body is not directly connected with the ratio of the flux along the normal to the surface of the body and the tangential flux along the generatrix of the body. Figures 8, references 11: 9 Russian, 2 Western.  
[254-6900]

UDC 533.697

#### MIXING MODES OF TRANSVERSE CO<sub>2</sub> JETS WITH SUPERSONIC STREAM OF NITROGEN IN NOZZLE

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 4, No 6, Dec 83  
(manuscript received 5 Jul 82) pp 954-958

VOLKOV, V. A., OSTROUKHOV, N. N. and TKACHENKO, B. K.

[Abstract] The present study employs visualization of flows to derive a picture of the flow structure, and estimates the dimensions of the region of intense interaction of flows with a CO<sub>2</sub> jet injected transversely into a nozzle into the expanding stream of a nitrogen-based gas mixture over a wide range of flow rates of the injected gas. Two modes of interaction between the jet and the flow in the nozzle are demonstrated. References 9: 8 Russian, 1 Western.  
[172-6900]

## CALCULATION OF TURBULENT FLOW IN CYLINDRICAL CHANNELS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 45, No 6, Dec 83  
(manuscript received 10 Nov 81) pp 940-942

ISMAGILOV, R. Kh.

[Abstract] The distribution function for the shear stress of a turbulent flow of liquid with constant viscosity in a cylindrical channel is found. Formulas are derived for calculating the velocity distribution profiles and the shear stress when the hydraulic drag of a channel varies in a known fashion. Figure 1, references 3 Russian.  
[172-6900]

## INVESTIGATION OF VARIATION IN DENSITY OF NEUTRAL GAS DURING TRANSMISSION OF REB PULSE

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 3, 12 Feb 84 (manuscript received 1 Dec 83) pp 162-165

IPATOV, A. L., KABANOV, S. N., KOROLEV, A. A., KUZ'MIN, A. I., KUL'BEDA, V. Ye., MKHEIDZE, G. P., NOSACH, V. Yu., RUKHADZE, A. A. and SAVIN, A. A.,  
Institute of General Physics, USSR Academy of Sciences

[Abstract] REB propagation in a dense molecular gas is studied on a Terek-1R accelerator with 10-15 kA beam current, 1.5 MeV electron energy and pulse length of approximately 60 nsec. The behavior of the gas density behind the REB pulse was investigated. The radial distribution densities of the gas are given for different elapsed times following the REB pulse. The behavior of the gas following an REB pulse varies significantly as a function of the beam current density. Investigation of the behavior of gas density subsequent to REB injection provides information on the relaxation kinetics of vibrational excited states. Figures 2, references 8: 7 Russian, 1 Western.  
[198-6900]

## DIFFUSION TRANSFER DURING NEAR-SONIC TURBULENCE

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 23 Nov 82) pp 2282-2283

KRUGEL', A. M., Leningrad Hydrological Institute

[Abstract] Corrections are made to the Einsteinian formula relating the coefficient of diffusion to the speed of sound and to the adiabatic exponent for turbulence that is strong in the sense that the kinetic energy density of

the turbulence is comparable to the internal energy density. The effective temperature of a turbulent gas is incremented by an amount proportional to the ratio of the turbulence energy to the thermal motion energy, with a corresponding change in the pressure, the adiabatic acoustic velocity of the turbulent gas and the expression for the coefficient of diffusion. The corrections derived are valid only when the average velocity of the turbulent fluctuations is high enough. Reference 1 Russian.  
[126-6900]

UDC 532.517.4

#### DERIVATION OF DEFINING RELATIONSHIPS OF TURBULENT LIQUID FOR BOUNDARY FLOWS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 24 Mar 83) pp 2245-2247

SKVORTSOV, G. Ye. and TIMOKHOV, L. A., Arctic and Antarctic Scientific Research Institute

[Abstract] Pulsation equations that yield a "microscopic" description of a turbulent liquid are employed to analyze large-scale boundary flow of an incompressible thermally homogeneous viscous liquid. The Reynolds stress is expressed through the turbulent viscosity and represented as the integral of a certain function and the spectral density of random forces. The turbulent viscosity is shown to be essentially a function of the Karman complex  $P$ . The method can be used to obtain all of the components of the Reynolds stress tensor. References 6: 5 Russian, 1 Western.  
[146-6900]

#### OPTICAL DETONATION IN GASES

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 27 Dec 82) pp 2148-2157

FISHER, V. I., Astronomical Observatory, Odessa State University imeni I. I. Mechnikov

[Abstract] The structure of a plane steady-state optical detonation wave front in hydrogen, helium and argon is examined; the principles underlying restructuring of the wave front as the laser radiation intensity varies are investigated. Steady-state movement of a plane shock wave in the direction opposite the laser radiation is examined, assuming that the laser radiation intensity is fixed. Ionization kinetics is discussed, and the equilibrium state of the plasma behind the wave is examined. Absorption of laser radiation is shown to occur mainly in the zone of non-equilibrium ionization. Figures 6, references 31: 23 Russian, 8 Western.  
[146-6900]



## SUPERSONIC MODES OF IONIZATION WAVE PROPAGATION ALONG LASER BEAM

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 28 Dec 82) pp 2143-2147

FISHER, V. I., Astronomical Observatory, Odessa State University imeni  
I. I. Mechnikov

[Abstract] A method is proposed for establishing the relationship between experimental conditions and discharge propagation modes in different gases. Steady-state movement of a plane ionization wave against the laser radiation is examined. Determination of the mode entails comparing the velocities of the ionization front in the optical detonation, radiation and fast ionization wave modes. The ionization wave velocity is given as a function of the laser radiation is different modes. The experimental conditions needed for investigating different modes are established; the equations derived make it easy to draw the boundary between modes regardless of external conditions. Figures 3, references 7 Russian.

[146-6900]

## PROPAGATION OF PLANE WAVES IN COMPRESSIBLE STRATIFIED LIQUID AND THEIR DIFFRACTION ON HALF-PLANE

Moscow K DOKLADY AKADEMII NAUK SSSR in Russian Vol 275, No 2, Mar 84  
(manuscript received 12 May 83) pp 318-322

SHATOV, A. K., Moscow State University imeni M. V. Lomonosov

[Abstract] The case in which internal as well as acoustic waves can exist in a compressible stratified liquid is examined. The relationship between the phase velocity of a plane wave and the group velocity is derived; the group velocity vector deviates toward the Oz axis with respect to the phase velocity vector. For internal waves the second component of the group velocity has the opposite sign of that component of the phase velocity. The problem of scattering of a plane acoustic wave on a hard half-plane is examined. The scattered field in the far zone, as well as the problem of scattering of internal waves, is analyzed. References 5 Russian.

[262-6900]



## PROPAGATION OF SHOCK WAVES FOLLOWING DOUBLE EXPLOSION IN GAS WITH BACKPRESSURE

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian  
No 5(141), Sep-Oct 83 (manuscript received 9 Aug 82) pp 98-103

ANDRIANKIN, E. I. and MYAGKOV, N. N., Moscow

[Abstract] Propagation of shock waves following two explosions in a gas is analyzed, taking into account the backpressure of the medium in front of the first wave-front. The explosions are assumed to occur at the same point in space ( $r=0$ ) but not simultaneously: the first at time  $t=t_0$  and the second at time  $t=0$ . The corresponding equations of gas dynamics have been solved numerically by the S. K. Godunov method with an implicit difference scheme and subsequent scaling on the basis of integral conservation laws with extraction of flow singularities. The solution is found to be controlled by two parameters, namely the ratio of the two explosion energies and the time interval between the two explosions. An evaluation of the results in the approximation of nonlinear acoustics indicates the conditions for independent propagation of the two shock waves and the possibility of stable discontinuity patterns with arbitrary profiles. Figures 5, references 10 Russian.  
[205-2415]

## FLOW STRUCTURES AND THEIR EVOLUTION IN TURBULENT SHEAR LAYER

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian  
No 5(141), Sep-Oct 83 (manuscript received 13 Oct 82) pp 74-80

KUZ'MIN, G. A., LIKHACHEV, O. A. and PATASHINSKIY, A. Z., Novosibirsk

[Abstract] The flow structure and its evolution in a turbulent shear layer are analyzed for purposes of physical and computer experiments, considering that turbulent motion of a fluid involves excitation of many strongly interacting degrees of freedom. This motion is neither perfectly random, accessible to simple statistical analysis, nor perfectly coherent, characterized by regular vortex clusters. The analysis is, therefore, based on two other models, considering that Helmholtz instability is the principal mechanism of flow structure evolution. The simpler model is that a vorticity distribution initially uniform over a thin boundary layer of a boundless nonviscous fluid. The corresponding Hamilton equations are formulated in the finite-dimensional approximation of vorticity, with the total kinetic energy playing the role of internal energy in the Hamiltonian and with the dimensionless intermittence parameters characterizing the evolution process. The more intricate model is a linear array of identically oriented clusters, each consisting of substructures at equilibrium statistically and the number of the latter increasing from some minimum to some maximum in the evolution process. Recurrence relations can be easily derived here, just as for the simpler model, but also taking

into account influence of and merger with adjacent structures as well a non-conservative moment of momentum. This is demonstrated on the specific example of evolution beginning with only two clusters. References 19: 7 Russian, 12 Western.  
[205-2415]

UDC 532.032+532.527

#### MOTION OF VORTEX PAIR BETWEEN PARALLEL WALLS

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian  
No 5(141) Sep-Oct 83 (manuscript received 1 Sep 82) pp 62-67

GESHEV, P. I. and YEZDIN, B. S., Novosibirsk

[Abstract] The motion of a vortex pair between parallel walls is analyzed from the kinematic standpoint, without use of Euler equations, since such a situation occurs not only in ideal fluids but also in superfluid helium and in strongly magnetic plasma with "vortical" flow of electrons and ions. The corresponding equations for a two-dimensional simply-connected bounded region are formulated in terms of the Hamiltonian for an array of  $N$  ideal vortices and conservation integrals for the "physical" region where they move. In the plane hydrodynamic case the flow function satisfies the Poisson equation and invariance of the Hamiltonian implies existence of an additional conservation integral, a "momentum" integral when the "physical" region is a circle or a "moment of momentum" integral when it is a rectangular strip. The problem is solved by conformal mapping, strip onto unit circle and vice versa. The result reveals that the motion of both vortices is completely defined by energy and momentum, each depending on the magnitude and the sign of their circulation ratio as well as on their initial locations. The equations of motion are found to be exactly integrable, without stochasticity of trajectories in a manifold of dimensionality  $n - k \leq 2$  ( $n$ - number of dimensions of phase space,  $k$ - number of integrals in dynamic system), just as in the case of three vortices moving in a boundless space but unlike in the case of four vortices under certain initial conditions. Figures 4, references 15: 11 Russian, 4 Western.  
[205-2415]

UDC 532.5+533.6

#### INITIAL STAGE OF SEPARATION FLOW AROUND CIRCULAR CYLINDER

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian  
No 5(141), Sep-Oct 83 (manuscript received 20 Jul 82) pp 42-46

ZOBNIN, A. I., Novosibirsk

[Abstract] A circular cylinder immersed in a fluid is perturbed transversely from its state of rest. For an analysis of the resulting two-dimensional flow, the fluid is assumed to be ideal and incompressible, and separation is assumed

to occur at the cylinder surface in the form of a single vortex trail. The corresponding boundary-value problem for potential flow outside the cylinder and the vortex trail is formulated as a Riemann-Hilbert problem in the complex plane, in accordance with the Thompson theorem of constant circulation rate around a closed contour, with boundary conditions of an impermeable cylinder surface, zero velocity at infinity, and a velocity jump at the vortex edge. This problem is known to have a unique solution, of particular interest here being the flow transient within the initial period asymptotically approaching time  $T = 0$ . Three scalar functions, each a function of time, are calculated accordingly:  $\mathcal{J}_*(t) = \mathcal{J}_0(t)$ ,  $\lambda(t) = 8 \lambda_0 \mathcal{J}_0^{-3/2} t^{-3}$ ,  $l(t) = 1/4 \mathcal{J}_0 t^2$ . The author thanks D. N. Gorelov for steady interest and valuable comments. Figure 1, references 8 Russian.

[205-2415]

UDC 533.951

#### LANGMUIR SOLITONS OF BERNSTEIN-GREEN-KRUSKAL TYPE

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 22 Dec 82, after correction 4 May 83) pp 206-208

MOKHOV, Yu. V. and CHUKBAR, K. V., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] The motion of ions in the low-frequency field of a Langmuir soliton is analyzed on the basis of the corresponding equations of hydrodynamics and charged-particle kinetics. The action of the high-frequency soliton pressure in a plasma results in formation of a self-consistent concentration cavity, with peak-to-trough transition of the low-frequency ion potential as the soliton velocity crosses the  $v_T = \sqrt{Te/m}$  level. An analysis of the relations governing this action, including the interaction of a moving soliton and drift electrons, reveals new effects depending on whether the system of coordinates moving with the soliton is inertial or noninertial. In the first case there occurs nonconservative energy transfer between particles and wave, with only reflected waves contributing to the Landau nonlinear attenuation. In the second case the energy transfer is proportional to acceleration, not to velocity, and contributes only to the effective mass. References 6: 5 Russian, 1 Western.

[206-2415]

# TURBULIZATION OF FLUIDS BY COHERENT OF NONCOHERENT LIGHT BEAMS AND RESPECTIVE THRESHOLDS OF THERMAL SELF-STRESS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 14 Mar 83) pp 148-157

GALICH, N. Ye., MARTYNENKO, O. G., POCHUKOTOV, V. Yu. and USTOK, Kh. Z.,  
Institute of Heat and Mass Transfer imeni A. V. Lykov, BSSR Academy of Sciences,  
Minsk

[Abstract] Propagation of light beams through fluids and resulting turbulization of the latter are analyzed for the case of long interaction time  $\tau > R^2/\alpha \gg R/c_s$  of the order of  $10^{-3}$  s ( $2R$ - width of light beam,  $c_s$ - sonic velocity in fluid,  $\alpha$ - thermal diffusivity of fluid) so that fluctuation and modulation as well as the nonuniformity of the light intensity become smooth. The transition to turbulence is described by equations of natural convection in the Boussinesq approximation, assuming that the path of light propagation is far from boundaries of the fluid medium. Calculations for a vertical light beam in a horizontal layer are done first for an initially quiescent gas ( $Pr \approx 1$ ), utilizing similitude with respect to both thermal and hydrodynamic processes, then for a gas with initial turbulence in the form of "moderate" convection ( $Pr \gg 1$ ). Calculations for a horizontal light beam in a vertical layer are done with cellular and curly convection patterns as well as convective oscillations taken into account. In this case the laminarity limit and turbulence threshold in the wake behind the light beam are determined from equations of laminar flow. Turbulization thresholds for coherent and noncoherent vertical light beams are found to be lower than thresholds of self-focusing or self-defocusing through nonlinear refraction, and much higher than the corresponding thresholds for horizontal light beams. Turbulization by the mechanism of light absorption is most effectively suppressed by shortening the interaction time so that hydrodynamic turbulence cannot develop.  
References 24: 21 Russian, 3 Western.  
[166-2415]



## LASERS AND MASERS

### CHEMICAL LASERS

Moscow PRAVDA in Russian 12 Mar 84 p 3

[Article by Academician Yu. Khariton: "Chemical Lasers in Competition for Lenin Prize"]

[Text] One of the most important features of modern science and technology is the increasing application of the advances of quantum electronics, specifically, of optical quantum generators--lasers. Materials are cut, their surfaces are machined, chemical transformations of substances are carried out, surgical operations are performed, data are transmitted, three-dimensional images are produced and the content of microimpurities, in the atmosphere, are analyzed by using a beam. Laser technology is used in conducting investigations in the most diverse fields of the natural and technical sciences--from controlled thermonuclear fusion to genetics.

It is natural that a wide range of requirements is placed on lasers themselves as sources of light energy. Very important among them are low weight, compactness of the optical generator and the efficiency of energy conversion processes.

Most modern lasers use electric power sources. This is frequently very convenient in practice. However, it is desirable in some cases to make the electric power sources considerably more compact or to eliminate them altogether.

The cycle "Fundamental investigations of chemical lasers in chain reactions," presented by the Physics Institute and Institute of Chemical Physics, USSR Academy of Sciences--organizations in which these investigations were conducted, has been entered in the competition for the 1984 Lenin Prize.

The authors began their investigations two decades ago, essentially immediately after the first lasers appeared and set themselves the goal of finding a method of direct conversion of chemical energy to laser energy. The task was very difficult. Avoiding the complexities of a strict scientific exposition, I note only that all the necessary characteristics of the desired chemical systems and methods of controlling them to create chemical lasers were formulated in the first theoretical works of the participants of the cycle under consideration.



The most important and experimentally developed hypothesis of the authors is the use of chemical chain reactions. The chain reaction that satisfied all conditions was explosion of a mixture consisting of molecular hydrogen or an isotope of it--deuterium--with molecular fluorine. The uniqueness and efficiency of the selected system and the reactions in them are indicated by the fact that now, after many years, these systems remain realistically the only ones for direct conversion of chemical energy to coherent light with high efficiency. It is typical that foreign investigators also used systems first used in the USSR to create efficient chemical lasers after publication of Soviet data.

The working processes in chemical lasers are very complex. The quantitative characteristics of very many so-called elementary chemical processes and energy transfer processes must be taken into account in theoretical calculations in the search for optimum conditions for conversion of chemical energy to light energy. The authors of the cycle of papers set up many experiments, during which more than 70 of these characteristics were measured by different physical methods. Each of these measurements represents very complicated experimental physical and physio-chemical research.

I would add to the foregoing only a mention of many important investigations included in the cycle. Thus, methods of preparation of active mixtures for use in a laser reactor were suggested on the basis of the branch-chain mechanism of hydrogen and fluorine reactions, discovered earlier in the Soviet Union. The methods of working with these reactors at ordinary (this is very convenient!) atmospheric pressure were also developed 6 years earlier than abroad.

The significance and originality of the research gained wide recognition by the Soviet and foreign scientific community.

I talked at the beginning of the article about the advantages of chemical lasers (compared to "electric" lasers) mainly from engineering positions, mainly due to the relatively small weight and overall dimensions of energy power sources. However, other significant advantages of chemical lasers based on chain reactions were also determined in time. The fact is that they emit in those regions of the electromagnetic spectrum (wavelength of 2.6-4.5 microns), for which there are not yet other powerful sources of emission. This emission is easily absorbed by most chemical compounds, but is hardly absorbed by those which mainly comprise the earth's atmosphere. As a result, on the one hand, many chemical transformations can be carried out by using the light of chemical lasers and, on the other hand, this can be done by transmitting light through the air without energy loss. Accordingly, one can expect the use of chemical lasers for analytical purposes and to monitor the condition of the environment. Many other applications in science and the national economy are also possible.

It is felt that the affiliation of one of the parts of the discovery to the Institute of Chemical Physics, USSR Academy of Sciences, where branched chemical chain reactions were discovered more than 50 years ago, and of the other part to the school of the Physics Institute, USSR Academy of Sciences, where "the laser era" was begun 30 years ago, contributed to the success of the author's collective. Their achievements deserve to be advanced for the competition of the Lenin Prize.

## LASERS IN THERMONUCLEAR FUSION, COMMUNICATIONS AND COMPUTER TECHNOLOGY

Moscow TRUD in Russian 15 Apr 84 p 2

BASOV, N. G., academician, laureate of the Lenin and Nobel prizes, member of the Presidium of the USSR Supreme Soviet

[Abstract] The author gives a lengthy discussion of applications of lasers in science and technology, referring a number of times to developments of the Physics Institute imeni Lebedev (FIAN).

He opens the discussion with advantages and prospects of pulsed inertial systems for thermonuclear fusion. Saying that there has been great progress on solving problems of laser fusion in recent years, with powerful multi-channel laser complexes existing in various countries, the author mentions FIAN's "Del'fin" unit—a 108-beam neodymium glass laser which went into operation in 1981. Experiments conducted with it are said to have confirmed Soviet scientists' conceptions about laser thermonuclear fusion, and have yielded a detailed picture of processes occurring when laser light acts on thermonuclear targets. The authors says Soviet scientists now consider the main problem to be in selecting the type of laser for a demonstration experiment aimed at achieving the physical threshold at which the reaction yields as much energy as is put into producing it by means of laser radiation. He says research now being done at FIAN on new lasers gives reason to expect this may be achieved in the near future. He adds that there are prospects for developing hybrid reactors which combine reactions of the fusion of isotopes of heavy hydrogen and the fission of uranium nuclei. Saying that development of such a hybrid is possible now with state-of-the-art laser technology, the author observes that as an intermediate step between stationary nuclear reactors and thermonuclear systems, the hybrid represents a 'compromise' that offers the most effective way to the ultimate goal.

Turning to prospective developments in electrooptics, the author reports that FIAN's work with industry institutes has produced models of semiconductor injection lasers which possess a long service life. Industrial production of such lasers will permit the solution of many problems in such fields as optical communications, detection and ranging, night vision, and optical memory. In the computer field, the author says unique possibilities for high-capacity memories have been opened by FIAN's development of a medium that is a kind of sandwich of layers of a semiconductor and dielectronics. When

voltage is applied to the sandwich, there occurs a redistribution of electrons in an area that is illuminated by laser radiation. A main memory with a capacity of one billion bits can be created from a certain structure of such medium that is only one-fourth of a square meter in area, the author claims.

The author also discusses laser metalworking and materials-treatment technologies. He mentions that a special affiliate of FIAN has been created in Kuybyshev to work on expediting the introduction of laser processes in industry.

FTD/SNAP

CSO: 1862/291

STUDY OF EMISSION SPECTRUM OF TEA CO<sub>2</sub> LASER WITH INTRACAVITY ABSORBER

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 3 FIZIKA ASTRONOMIYA in Russian Vol 24, No 4, Jul-Aug 83 (manuscript received 13 Dec 82) pp 62-64

VASIL'YEV, A. B. and FEDOSEYEV, A. I.

[Abstract] When high-energy P branch vibrational-rotational levels are combined with the main laser transition of the CO<sub>2</sub> molecule (wavelength 10.6 micrometers) in a laser emission spectrum consisting of several lines, short radiation pulses with lengths equal to the rotational relaxation time can be increased in power by 20-40%. The study showed that by introducing selective losses it was possible to obtain the required simultaneous lasing of the vibrational-rotational lines. The optical cavity consisted of copper mirrors and a heat cell containing CO<sub>2</sub> acting as a nonlinear absorber was located inside the cavity. The temperature of the intracavity cell was varied in the range of 400-700 K, and maximum amplification was obtained at 400 K while power fell off at higher levels. Further optimization was not carried out and thus maximum laser radiation did not exceed 100 kW, but performance can be improved. Figure 1, references 3: 2 Russian, 1 Western.  
[165-12497]

EFFICIENT LASER EMPLOYING OPTICALLY STABLE F<sub>2</sub> CENTERS IN LiF CRYSTALS

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 4, 26 Feb 84 (manuscript received 9 Nov 83) pp 248-251

VASIL'YEV, S. G., ISYANOVA, Ye. D., LOBANOV, B. D., MAKSIMOVA, N. T., OVCHINNIKOV, V. M., PROVOROV, A. M. and TSIRUL'NIK, P. A.

[Abstract] A medium with optically stable F<sub>2</sub> color centers is obtained and employed to build a high-efficiency laser. The processes underlying the optical destruction of F<sub>2</sub> color centers are discussed. An F<sub>2</sub>-center distribution is achieved in which destruction due to electron transition to adjacent defects is prevented. The absorption spectrum of the crystal is shown. The relationship between the output energy of the laser, and the pumping energy is described. Figures 2, references 8: 4 Russian, 4 Western.  
[192-6900]



#### PASSIVE SHUTTER OF RADIATION-DYED LEUCOSAPPHIRE FOR RUBY LASER

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 4,  
26 Feb 84 (manuscript received 16 Nov 83) pp 219-221

MIKHNOV, S. A., USKOV, V. I., KORDA, I. M., CHERENDA, N. G. and BILAN, O. N.,  
Institute of Physics, Belorussian SSR Academy of Sciences

[Abstract] The leucosapphire crystals investigated were irradiated with neutrons. The absorption spectrum of radiation-dyed sapphire in the 600-800 nm region is shown. Lasing time and energy characteristics are investigated. A lasing energy of 0.19 J is achieved with pumping energy of 690 J corresponding to the giant pulse lasing threshold for a shutter with optical density  $D=0.22$ . The use of an analogous crystal as a shutter for passive mode locking of a ruby laser is investigated. Mode locking was observed when the pumping energy exceeded the threshold value of giant pulse lasing by only a slight amount. Rotating the crystal through  $90^\circ$  caused the single pulse energy to drop to 0.5 J. Figures 2, references 3 Russian.  
[192-6900]

#### CONTINUOUS LASING IN HELIUM-EUROPIUM COLLISION LASER

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 4,  
26 Feb 84 (manuscript received 31 Oct 83) pp 210-214

BOKHAN, P. A., Institute of Thermal Physics, Siberian Department, USSR Academy of Sciences

[Abstract] Continuous collision lasing in the near IR band at  $1.0019 \mu\text{m}$  is achieved in an ionized-europium laser. It is shown experimentally that such lasers can produce coherent radiation in the  $1 \mu\text{m}$  region in both the pulsed and CW modes. The power actually achieved in the different modes is 1-4 orders of magnitude lower than the predicted power because of the power efficiency with which resonant levels are excited due to the smallness of  $T_e$  in the gas discharge (approximately 1 eV). Figures 2, references 7: 6 Russian, 1 Western.  
[192-6900]

UDC 621.382.3

#### CONTINUOUS LASING OF AlGaAsSb/GaSb-HETEROLASERS AT ROOM TEMPERATURE

Tallin IZVESTIYA AKADEMII NAUK ESTONSKOY SSR: FIZIKA MATEMATIKA in Russian Vol 33, No 1, Jan-Mar 84 pp 128-130

AARIK, Ya., BERGMANN, Ya., VIRRO, A., LYUK, P., ROZENTAL', A., SAMMELSEL', G. V. and FRIDENTAL', Ya.

[Abstract] It is demonstrated that it is possible to grow heterostructures with active region thicknesses of up to  $0.2 \mu\text{m}$  even at  $570^\circ\text{C}$  if the epitaxy



temperature conditions and melt compositions are selected properly. AlGaAsSb/GaSb injection lasers capable of continuous wave operation at room temperature are created. Lasers with an active region of gallium antimonide are demonstrated to be capable of continuous wave operation at temperatures significantly higher than room temperature, indicating the practical applicability of uncooled AlGaAsSb/GaSb injection lasers. References 8: 7 Russian, 1 Western. [244-6900]

UDC 621.382.3

#### ANOMOLOUS TUNING OF AlGaAsSb/GaSb AND AlGaSb/GaSb-LASERS BY TEMPERATURE AND PRESSURE

Tallin IZVESTIYA AKADEMII NAUK ESTONSKOY SSR: FIZIKA MATEMATIKA in Russian Vol 33, No 1, Jan-Mar 84 pp 35-43

AARIK, Ya., VIRRO, A., GERST, A., LYUK, P., NIYLISK, A., ROZENTAL', A., SAMMELSEL'G, V. and FRIDENTAL, Ya., Institute of Physics Estonian SSR Academy of Sciences

[Abstract] Abrupt adjustment of AlGaAsSb/GaSb and AlGaSb/GaSb injection lasers with a bilateral heterostructure and employing no composite cavity is investigated. The laser heterostructures employed were obtained by liquid phase epitaxy; an MDR-23 monochromator was used to measure the radiation spectra. The influence of multichannel lasing on the occurrence of frequency hopping is determined to stem from the unintentional formation of a composite cavity in the laser, with additional reflection resulting from defects due to tensile stresses. The need for improving fabrication technology by reducing mechanical stresses, or at least preventing the formation of defects, is pointed out. Figures 7, references 18: 6 Russian, 12 Western. [244-6900]

#### NEW THIN-FILM FAST-RELAXATION PHOTOTROPIC SHUTTERS FOR PICOSECOND NEODYMIUM LASERS

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 3, 12 Feb 84 (manuscript received 9 Nov 83) pp 157-161

GIBELEV, A. I., DOKUKINA, A. F., YEREMEYEVA, Ye. P., ISYANOVA, Ye. D., OVCHINNIKOV, V. M. and SMIRNOVA, Z. A.

[Abstract] New thin-film passive laser shutters based on a polymer matrix for neodymium lasers are fabricated and investigated. Stable self-made locking is achieved. The photochemical strength of the shutters is high, and their operating convenience allows them to be employed in place of liquid shutters. References 6: 5 Russian, 1 Western. [198-6900]

INFLUENCE OF RELATIVE SPECTRAL POSITION OF AMPLIFICATION BAND AND LASING LINE  
ON RADIATION DYNAMICS OF HETEROLASER WITH BRAGG REFLECTORS

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 10, No 3,  
12 Feb 84 (manuscript received 12 Dec 83) pp 133-138

GUREVICH, S. A., IL'ICH, A. A., PORTNOY, Ye. L. and TIMOFEYEV, F. N., Physical-  
Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] The lasing dynamics of an injection-distributed Bragg-reflector laser employing a design providing low lasing thresholds at room temperature is investigated. A saturation absorber is employed in the Bragg reflector. The lasing dynamics of Ga(Al)As strip lasers pumped with bell-shaped pulses approximately 60 ns long at the half-amplitude level was investigated (pulse repetition frequency 3 KHz). A qualitative model is presented to account for the changes in the dynamic modes, which are apparently caused by the amount and nature of loss saturation in the corrugated layer of the heterolaser. An experiment on monolithic hybrid Bragg-reflector heterolasers indicates that the dynamic changes occur there as well. It is shown to be possible to select a dynamic operating mode of a laser by changing the temperature of the specimen, or by selecting the period of the corrugation in the distributed Bragg reflectors. References 16: 6 Russian, 10 Western.  
[198-6900]

UDC 535.8

USE OF SEMICONDUCTOR LASER IN COHERENT OPTICAL VELOCITY METER

Novosibirsk AVTOMETRIYA in Russian No 1, Jan-Feb 84 (manuscript received  
3 Jun 83) pp 110-111

DUBNISHCHEV, Yu. N., ZHMUD', V. A., PAVLOV, V. A. and STOLPOVSKIY, A. A.

[Abstract] The use of an ILPN-2K semiconductor laser in a working laser Doppler anemometer prototype employing a differential arrangement is described. The optical arrangement and schematics of the device are shown. The output signal of the photodetector obtained with the scatterer moving in different cross sections of the probing interference field is analyzed. Figures 3, references 4: 2 Russian, 2 Western.  
[242-6900]

## EXPERIMENTS IN DEVELOPMENT OF POWERFUL DYE LASER

Novosibirsk AVTOMETRIYA in Russian No 1, Jan-Feb 84 (manuscript received 11 May 83; revised 23 Aug 83) pp 82-85

ALFEROV, G. N., DONIN, V. I. and TELEGIN, G. G.

[Abstract] An experimental setup is described for investigating a rhodamine 6G laser employing ethylene glycol as well as water solvent. Pure ethylene glycol can be used to achieve lasing power of 10 watts or more in a rhodamine 6G laser pumped by an argon laser. However, aqueous solutions are needed to increase the output power of an ordinary laser further. Special chemical additives are required in order to improve dye lasing efficiency when water is used as the solvent. Figures 3, references 5: 2 Russian, 3 Western. [242-6900]

## OBTAINING POWERFUL LIGHT PULSES WITH HIGH REPUTATION FREQUENCY IN ARGON MODE-LOCKED LASER - AMPLIFIER SYSTEM

Novosibirsk AVTOMETRIYA in Russian No 1, Jan-Feb 84 (manuscript received 26 May 83) pp 65-70

APOLONSKIY, A. A. and DONIN, V. I.

[Abstract] The possibility of obtaining powerful radiation with high repetition frequencies and short pulse durations in a system consisting of an argon mode-locked laser and multipass amplifier are analyzed theoretically and experimentally; mod-locked laser characteristics are investigated experimentally. The multipass argon amplifier employed, which is based on existing high-current discharge principles, will probably soon make it possible to obtain 0.1-ns light pulses at repetition frequencies of 100 MHz and average power of up to 100 W in Ar II. Figures 3, references 18: 10 Russian, 8 Western. [242-6900]

## LASER RESONATORS WITH NONUNIFORM MIRRORS

Novosibirsk AVTOMETRIYA in Russian No 1, Jan-Feb 84 (manuscript received 17 Mar 83) pp 50-58

KOL'CHENKO, A. P., NIKITENKO, A. G., TROITSKIY, Yu. V.

[Abstract] Methods for obtaining "non-Gaussian" laser beams in which the coherence and other qualitative characteristics are retained are described. Methods for fabricating nonuniform equiphase mirrors are discussed, and the efficiency of nonuniform energy output is analyzed. The uses of nonuniform mirrors in lasers include passive interferometers with nonuniform exit mirrors, in which the modes will be near-Gaussian so that the input can be almost fully matched with an ordinary laser beam, while the intensity distribution in the exit beam is a strong function of the transmission profile of the exit mirror. Figures 6, references 17: 12 Russian, 5 Western.  
[242-6900]

## UTILIZATION OF GAS MICROWAVE DISCHARGE IN HELIUM-NEON LASERS

Novosibirsk AVTOMETRIYA in Russian No 1, Jan-Feb 84 (manuscript received 30 Mar 83; revised 31 Aug 83) pp 35-45

GELLER, V. M., GRIF, G. I. and KHRUSTALEV, V. A.

[Abstract] A number of alternative designs of helium-neon lasers employing transverse microwave discharge are described. Strip and sectorial microwave cavities are shown to provide insufficient laser power boosting because they are not capable of exciting large volumes of active medium while maintaining sufficient gain. This deficiency is overcome by using coaxial and coaxial-conical discharge channels and microwave cavities. Relative optical lasing power, radiated laser power and helium-neon mixture gain are described as a function of the excitation power, as well as other experimental relationships obtained on a helium-neon laser developed by the authors. Superior output characteristics can be obtained by using microwave discharge for exciting lasers rather than direct current. The use of microwave excitation in coaxial discharge channels increases the output power of the optical radiation and makes it easy to achieve lasing modes at different wavelengths in the same active medium. Figures 15, references 34: 30 Russian, 4 Western.  
[242-6900]

## METAL-VAPOR ION LASERS WITH TRANSVERSE TYPES OF DISCHARGE

Novosibirsk AVTOMETRIYA in Russian No 1, Jan-Feb 84 (manuscript received 8 Feb 83; revised 20 Jun 83) pp 19-34

IVANOV, I. G.

[Abstract] This study reviews basic findings on hollow-cathode discharge and transverse HF discharge lasers, both CW and quasicontinuous as well as driven by microsecond pulses; excitation characteristics and methods of creating metal vapors are examined, and the designs employed in active laser elements are described. The main emphasis is on the energy characteristics of the output radiation. Potential areas of application of transverse-discharge lasers are enumerated. Figures 3, references 68: 28 Russian, 40 Western. [242-6900]

SUPERLUMINESCENT RADIATORS BASED ON GaInAsP-InP HETEROSTRUCTURES WITH 1.3-1.55  $\mu\text{m}$  RADIATION WAVELENGTH

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83 (manuscript received 7 Dec 82) pp 2286-2288

GOLIKOVA, Ye. G., GVOZDEV, A. A., DURAYEV, V. P., MAL'KOVA, N. V., NEDELIN, Ye. T., SVERDLOV, B. N., SUMAROKOV, Vm. A. and SHELYAKIN, A. A.

[Abstract] Superluminescent radiators based on GaInAsP-InP heterostructures with radiation wavelength of 1.3-1.5  $\mu\text{m}$  are shown to have good space-time and spectral characteristics and long service life. The superluminescent radiators operating at 1.3  $\mu\text{m}$  were grown on N- and P-type substrates; the 1.55  $\mu\text{m}$  radiators include a buried-stripe laser: pInP (substrate) - pInP - nGa<sub>0.40</sub>In<sub>0.60</sub>As<sub>0.66</sub>P<sub>0.34</sub>-nGa<sub>0.28</sub>In<sub>0.72</sub>As<sub>0.58</sub>P<sub>0.42</sub>-nGa<sub>0.11</sub>In<sub>0.89</sub>As<sub>0.26</sub>P<sub>0.74</sub>. The speed of the superluminescent radiators is determined basically by the time delay of the light pulse with respect to the current pulse, which varies from 10 to 2 ns as the pumping current increases. Figures 2, references 5: 3 Russian, 2 Western. [146-6900]



## MEASUREMENT OF INTERNAL PERFORMANCE PARAMETERS OF SEGMENTAL LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84

(manuscript received 14 Feb 83, after completion 22 Jul 83) pp 219-221

MASYUKOV, V. A., Institute of Problems in Mechanics, USSR Academy of Sciences, Moscow

[Abstract] A method of varying the active length has been developed for measuring three internal performance parameters of a laser, namely small signal gain, saturation intensity, and intracavity loss. This method is now extended to lasers consisting of two identical segments between two mirrors with known but different losses. It involves making three absolute power measurements:  $P_1$  and  $P_2$  on the segment adjacent to the back mirror and the segment adjacent to the exit mirror respectively turned on and the other segment turned off, and  $P_3$  with both segments turned on. The three sought parameters are determined from these three power readings in accordance with known relations between them. The method does not require loss calibration inside the resonator, which simplifies measurements on power lasers. The necessary calculations are shown for a laser with distributed losses, high gain and a uniformly widened emission line. Readings actually taken on a  $\text{CO}_2$ -laser with a  $\text{CO}_2:\text{N}_2:\text{He} = 1:1:6$  active mixture under a total pressure of 2.7 kPa and circulating at a rate of 15 liters/min, and with an active length  $L = 1.84$  m between a copper back mirror and an NaCl (two plane-parallel plates) exit mirror, were  $P_1 = 37$  W,  $P_2 = 38.7$  W,  $P_3 = 125$  W, all within  $\pm 10\%$  and  $P_1/P_2$  with  $\pm 1\%$ , at input power of 205 W/m. Figure 1, references 13: 4 Russian, 9 Western.

[166-2415]

UDC 621.373.826.038.823

## MULTIFREQUENCY EMISSION FROM SUBMILLIMETER LASERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84

(manuscript received 22 Jul 83) pp 213-214

KAMENEV, Yu. Ye., KULESHOV, Ye. M. and LEBEDENKO, A. N., Institute of Radio-physics and Electronics, UkrSSR Academy of Sciences, Kharkov

[Abstract] Considering that simultaneous excitation of several longitudinal modes in a submillimeter laser is not possible because the lines of lasing transitions are narrower than the frequency separation between longitudinal resonances, an experimental feasibility study was successfully made with submillimeter radiation from a waveguide HCN-laser ( $\lambda_0 = 337 \mu\text{m}$ ) operating on two frequencies with linear parallel polarizations of modes or at three frequencies with linear parallel and linear orthogonal polarizations of modes. Such a laser was built with a hollow dielectric waveguide between two mirrors as resonator, with the exit mirror consisting of two crossed uniform wire

gratings. With the radius of the waveguide fixed, its length or distance between mirrors was adjusted so as to satisfy the condition for coincidence of the longitudinal resonances of two compound modes  $(TE_{01} + EH_{21})_q$  and  $(TE_{02} + EH_{22})_{q-1}$  with  $u_{nm} = 3.83$  and  $u_{nm} = 7.016$ , respectively ( $q$ -longitudinal index,  $u_{nm}$  -  $m$ -th root of Bessel function of first kind and  $n$ -th order for given mode). The radiation spectrum of this laser was monitored with a single-mode auxiliary HCN laser. An additional feature of this laser was found to be smooth tunability of the frequency difference. The beat frequency of orthogonally polarized modes was varied by parallel shifting of one of the two wire gratings. Figure 1, references 6: 3 Russian, 3 Western. [166-2415]

UDC 621.373.826.038.825.2

# PICOSECOND PARAMETRIC OPTICAL OSCILLATOR WITH AMPLIFICATION OF RADIATION FROM TUNABLE SEMICONDUCTOR LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 28 Jul 83) pp 203-205

BOYCHENKO, V. L., ZASAVITSKIY, I. I., KOSICHKIN, Yu. V., TARASEVICH, A. P., TUNKIN, V. G. and SHOTOV, A. P., Institute of Physics imeni P. N. Lebedev and Institute of General Physics, USSR Academy of Sciences, Moscow

[Abstract] Amplification of narrow-band seeding radiation is considered as a method of producing finite-spectrum  $(\Delta \omega)$  picosecond  $(\tau)$  emission pulses from the frequency-tunable laser of a parametric optical oscillator for spectroscopy, which requires that  $\tau \Delta \omega \approx 1$ , a method more effective than use of two crystals. The seeding source must be a wavelength-tunable one, with injection lasers on  $AlGaAs$  or  $InGaAsP$  semiconductors being particularly suitable for this purpose. A parametric optical oscillator using an  $LiNbO_3$  crystal has been developed and built accordingly, with amplification of seeding radiation from a PbS-laser ( $\lambda_s \approx 4.0 \mu m$ ,  $\tau_s \approx 0.8 \mu s$ ) and with pumping of the latter by a single pulse from a glass:  $Nd^{3+}$  laser ( $\lambda_p \approx 1.06 \mu m$ ,  $E_p \approx 2$  mJ,  $\tau_p \approx 6-7$  ns). Such a semiconductor amplifier laser is tunable over the  $0.6-40 \mu m$  range of wavelengths by controlling temperature, pumping current, pressure or magnetic field intensity. This particular one operates at temperatures of liquid nitrogen, emitting radiation pulses of 2 mW power and  $0.8 \mu s$  duration with more than 10 spectral modes contained in each pulse. At least two or three modes are generated at every instant of time during a pulse, one of them usually predominating in terms of intensity but its power not exceeding 0.1 mW. This corresponds to an emission linewidth of  $10^{-5} cm^{-1}$  continuously tunable over a range of  $1 cm^{-1}$ . The optical oscillator is built on an  $LiNbO_3$  crystal, 2.5 cm long and cut at  $45^\circ$  to its optical axis, with vector synchronism for parametric three-frequency interaction  $\lambda_p^{-1} = \lambda_s^{-1} + \lambda_0^{-1}$  ( $\lambda_0$  - oscillator wavelength under no load). The pumping radiation is a beam 3 mm in diameter, and the seeding radiation is focused into a beam 1.5 mm in diameter and superposed on the pumping beam at a  $3^\circ$  noncollinearity angle inside the  $LiNbO_3$  crystal. Synchronization of the amplifier laser with the picosecond oscillator laser is achieved by means of a photodiode receiving a

part of the oscillator radiation. The oscillator frequency can be varied through a  $70 \text{ cm}^{-1}$  range by varying the temperature of the semiconductor laser over the 60-80 K range. The authors thank A. I. Nadezhdinskiy for helpful suggestions and discussion of the results. Figure 1, references 5: 2 Russian, 3 Western.  
[166-2415]

UDC 621.373.826.038.823

# CHARACTERISTIC FEATURES OF $\text{H}_2$ -He GAS MIXTURE AS ACTIVE LASER MEDIUM WITH OPTICAL PUMPING

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 28 Apr 83) pp 197-198

ZUYEV, V. S., KANAYEV, A. V. and MIKHEYEV, L. D., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Optical pumping of the  $\text{H}_2$ -He gas mixture is considered as means of exciting hydrogen within a continuum in the far vacuum ultraviolet region of the spectrum. The process involves absorption of a photon  $\text{H}_2 + h\nu \rightarrow \text{H}^*(2s, 2p) \text{H}(1s)$  and formation of excimer  $\text{HeH}^*$ :  $\text{H}^*(2s, 2p) + 2\text{He} \xrightarrow{K_1} \text{HeH}^* + \text{He}$ , followed by reactions  $\text{H}^* \xrightarrow{T_1} \text{H}(1s) + \text{H}(1s) + h\nu$ ,  $\text{HeH}^* \xrightarrow{T_2} \text{He} + \text{H} + h\nu$  and  $\text{H} + \text{H} + \text{He} \xrightarrow{K_2} \text{H}_2 + \text{He}$ . The concentration of excited particles is calculated from the system of equations describing the kinetics of these five reactions. The solution yields a gain of  $5 \cdot 10^{-2} \text{ cm}^{-1}$  at the A - X transition of the  $\text{HeH}^*$  excimer, which is quite sufficient for laser emission at wavelengths  $\lambda \gtrsim 400 \text{ nm}$ . Heating the mixture to 4000 K should extend the range of laser emission wavelength to 220 nm. Figures 1, references 13: 9 Russian, 4 Western.  
[166-2415]

UDC 621.373.826:534.8

# ACOUSTIC MODULATION OF RADIATION INTENSITY OF SOLID-STATE LASERS BY MEANS OF OSCILLATING MIRROR

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 17 May 83) pp 192-194

BELOVA, G. N. and REMIZOVA, Ye. I., Institute of Acoustics imeni N. N. Andreyev, USSR Academy of Sciences, Moscow

[Abstract] Acoustic modulation of the intensity of radiation from YAG and ruby lasers by means of a periodically oscillating mirror was studied experimentally, with a plane-parallel active element placed between two plane mirrors and the back mirror made to oscillate about the resonator axis so as to cause its inclination to that axis to alternate periodically. Measurements yielded the

dependence of the relative peak laser radiation intensity on the mirror oscillation amplitude at various pumping power levels, from 1.5 W (modulation threshold) to 3 W, with these peaks coinciding with zero-crossovers of the mirror inclination angle and their number increasing as the pumping power increases or as the amplitude of mirror oscillations decreases. The results reveal that acoustic modulation has qualitatively the same characteristics for both lasers but quantitatively less effectiveness, only approximately half the modulation depth under identical conditions, in the case of a ruby laser. Figures 2, references 6: 5 Russian, 1 Western.  
[166-2415]

UDC 621.373.826.038.823

#### WAVEGUIDE CO<sub>2</sub>-LASER WITH 7.5 W POWER RATING

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 6 May 83) pp 184-187

BELYANKO, A. Ye., LIPATOV, N. I., PASHININ, P. P., POLIVANOV, Yu. N., PROKHOROV, A. M., SAKHANOVA, V. V. and YUROV, V. Yu., Institute of General Physics, USSR Academy of Sciences, Moscow

[Abstract] Gas lasers with cylindrical waveguides and electric pumping are considered for scientific and engineering applications, important being the conditions for maximum continuous-wave emission power per unit waveguide length as a measure of their performance capability. For the purpose of establishing these conditions, an experimental CO<sub>2</sub>-laser was built and tested with a waveguide made of beryllia and with either direct-current or capacitive high-frequency discharge available. The cylindrical BeO waveguide was 170 mm long and 3 mm in diameter, the resonator being formed by this waveguide, a spherical mirror with a radius of 2 m and a gold-coated surface, and a plane exit mirror on a BaF<sub>2</sub> substrate with a 0.7-0.9 reflection coefficient. Losses were minimized by placing each mirror no more than 2 mm away from the corresponding end of the waveguide. The laser output power was measured as a function of the gas pressure and discharge current (power) for various CO<sub>2</sub>-He, CO<sub>2</sub>-N<sub>2</sub>-He, and CO<sub>2</sub>-N<sub>2</sub>-He-Xe gas mixtures. Maximum output power of 5 W was attained with d.c. discharge under a pressure of 50 mm Hg in the CO<sub>2</sub>:N<sub>2</sub>:He = 1:1:7 mixture, but circulating the latter increased the power by 25% under a pressure of 80-90 mm Hg, and cooling the waveguide with tap water increased the laser efficiency to 13.5%. An output power of 7.5 W was reached by adding in a ratio of CO<sub>2</sub>:N<sub>2</sub>:He:Xe = 1:1:7:0.5, and cooling the waveguide with liquid nitrogen vapor, but under these conditions the life of the exit mirror was shortened by melting and cracking of the BaF<sub>2</sub> substrate with resulting damage to the reflective coating. The advantages of h.f. discharge over d.c. discharge are a much lower electric field intensity needed for sustaining the plasma and use of reactive elements rather than ballast resistors for matching the discharge circuit with the oscillator. Capacitive electrodes can, furthermore, be insulated from the discharge gap by a dielectric coating layer. In compound d.c. and h.f. discharge, which ensures a more uniform glow distribution, h.f. discharge acts as preionizer when its power is higher than the d.c. power, and the d.c. discharge ensures self-sustainance of the plasma when its power is comparable with or higher than the h.f. power. The authors thank V. N. Shkilev for assistance in preparing the experiments. Figures 2, references 10:

4 Russian, 6 Western.  
[166-2415]



## QUALITATIVE ANALYSIS OF THRESHOLD CURRENT IN QUANTUM-SIZE SEMICONDUCTOR LASERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84

(manuscript received 29 Apr 83) pp 178-181

YELISEYEV, P. G. and DRAKIN, A. Ye., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] A qualitative analysis of quantum-size semiconductor lasers in two configurations, planar and filamentary, reveals three ways in which their performance can be improved in terms of a lower threshold current and a weaker temperature dependence of the latter. The first involved modifying the energy dependence of the density of states  $\rho(E)$  in a rectangular potential well, with a constraint on the motion of free particles, thus strongly degenerating the electron gas so as to control not only the threshold current but also the wavelength of laser radiation. The second is enhancing the capture of charge carriers, which is facilitated by tunneling and achievable by a "step wave" or smoothly tapering potential well. The third way is to increase the parameter of optical limitation so as to suppress diffraction by shifting the optimum layer thickness downward, the optical limitation parameter being inversely proportional to the layer thickness squared in the case of a planar configuration. These three techniques as well as the resulting energy band structure and distribution of the density of states are demonstrated on models of bilateral and "separate limitation" heterostructures, quantitatively also on a typical GaInPAs/InP heterostructure lasing at the 1.3  $\mu\text{m}$  wavelength. Figures 3, references 9: 3 Russian, 6 Western.

[166-2415]

## PRODUCING NONABERRATIONAL LASER RADIATION WITH NEODYMIUM GLASS PLATES

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84

(manuscript received 4 Apr 83) pp 173-176

BRODOV, M. Ye., IVANOV, A. V., IVASHKIN, P. I., KORYAKOVSKIY, A. S., MARCHENKO, V. M., PASHININ, P. P., PROKHOROV, A. M., SEROV, R. V. and SHASHKOV, Ye. V., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] An experimental study was done on wavefront distortions during the passage of laser radiation through an active element with double reflection by polished lateral surfaces and attendant amplitude-phase modulation. Measurements were done with a Talbot interferometer by a method analogous to Hartmann shadow-interferometry, with Talbot interferograms being recorded by scalding of the exposed photoemulsion, and with a photometric wedge for determining the divergence of the laser beam in the focal plane of an  $f = 1.6$  m objective. The



laser amplifier module was a 3.6x24x74 cm rectangular plate of GLS-22 phosphate glass containing neodymium in a three-pass (two reflections) configuration. Evaluation of its optical characteristics in the absence of pumping revealed nonplanarity of the lateral reflecting surfaces as the principal source of astigmatic distortions at large incidence angles. An appropriate correction facilitated subsequent measurement of distortions caused by pumping during a single pass. These measurements have revealed that wavefront distortions during passage through such an active element with pumping through its lateral surfaces become one-dimensional at the instant of maximum inversion and can be approximately corrected with a cylindrical lens. Residual wavefront distortion in the parallel semichannel was found to decay within a short period (10 s) after a pumping pulse. The authors thank S. A. Abrosimov for assisting with the experiments. Figures 3, references 8 Russian. [166-2415]

UDC 621.373.826.038.823

#### DEPENDENCE OF RADIATION EMISSION PARAMETERS OF COMPLEX ORGANIC COMPOUNDS IN GASEOUS PHASE ON PUMPING WAVELENGTH

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 19 Apr 83) pp 163-166

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[Abstract] The radiation emission parameters of 1,4-bis[2-5(phenyloxazolyl)], benzene (POPOP) and para-bis[2-(5-para-biphenylyloxazolyl)] benzene (BOPOB) in vapor were measured for the purpose of determining their dependence on the pumping wavelength, considering that generally the fluorescence quantum yield from pure vapor drops sharply as the margin of vibrational energy in its molecules increases. These vapors were excited transversely by optical pumping at wavelengths of 248, 308, 350 nm with KrF\*, XeCl\* and XeF\* excimer lasers respectively and on 337 nm with a nitrogen laser. The results reveal that both substances in vapor produce a laser at  $\lambda = 248$  nm, with a  $15,3000 \text{ cm}^{-1}$  margin of vibrational energy, which they cannot do in solution. Both substances have close emission thresholds at the other wavelengths as well, with both lasing at shorter wavelengths in vapor than in solution and the thresholds being sufficiently low to make it feasible to achieve lasing with noncoherent pumping. Figure 1, tables 2, references 19: 15 Russian, 4 Western. [166-2415]

## EMISSION FROM NEODYMIUM-GLASS NEEDLE LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 24 Feb 82) pp 137-141

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[Abstract] An experimental study was made of stimulated emission from Silicate glass containing trivalent neodymium in the form of thin rods 40 cm long and 1 mm in diameter. Such a laser source inside a quartz tube was excited with two IPF-5000 xenon flash lamps connected in series and placed at the foci of an elliptical reflector with cooling pure water or, for cutting off the ultraviolet part of the pump spectrum, an aqueous solution of potassium dichromate. Generation of regular giant radiation pulses in such a needle laser was found to be facilitated not only by formation of short-lived color centers with consequent periodic Q-switching or by spontaneous Q-switching during clearing of color centers, just as in the case of fiber lasers, but also by relaxation processes characteristic of rod lasers. The results reveal that cooling with distilled water facilitates generation of 20-70 ns giant pulses with a 35-45  $\mu$ s repetition period, with their intensity and duration being controllable by addition of potassium dichromate. At high  $K_2Cr_2O_7$  concentrations and in the attendant complete absence of absorption centers, undamped regular pulses vanish along with cessation of Q-switching and damped transient pulses appear before steady-state emission begins. While needle lasers with dull base surfaces emit regular pulses, when water-cooled, with polished base surfaces (refractive index  $n_0 = 1.54$ ) they emit two kinds of pulses together: 40 ns giant pulses with a 30-40  $\mu$ s repetition period and 200-250 ns dwarf pulses. The former are produced by reflections from the base surfaces and resulting longitudinal oscillations. The latter are produced by reflections from the lateral surfaces and resulting circular oscillations, the number of circular modes depending on the refractive index of the active medium relative to that of the ambient medium. Figures 5, references 12 Russian.

[166-2415]

## CLARIFIABLE FILTER BASED ON DITHIENE FOR IODINE LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 18 Feb 83) pp 115-119

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[Abstract] The use of special compounds, three dithienes (tetrathiotetracene monopicrate  $C_{24}H_{10}N_3O_7S_4$ , tetrathiotetracene monoperchlorate  $C_{18}H_8Cl$ , tetrathiotetracene monoacetate) and some radical cations in passive laser

shutters is examined for Q-switched iodine lasers. Experiments were performed with various solvents (nitrobenzene, sulfolan, 1,2-dichloroethane,  $\text{CF}_3\text{COOH}$ ,  $\text{CF}_3\text{COOH}/\text{CH}_3\text{COOH}$ ,  $\text{CH}_3\text{CN}$ , N-methyl-2-pyrrolidone and N,N-dimethylformamide). Measurements were made with an iodine laser containing a  $\text{C}_3\text{F}_7\text{I}:\text{SF}_6:\text{He} = 1:3:30$  mixture under a total pressure of 0.6 atm and pumped by a symmetric array of four IFP-20000 xenon flash lamps. For comparison, measurements were also made with other infrared lasers: neodymium and ruby. The results indicate that the dithienes, with adequate phototropism, are suitable for this purpose, with their additional advantages of low toxicity and high pourability. Some radical cations do not saturate even at high laser radiation intensity, owing to fast relaxation of the excited state. Other radicals become less transparent with increasing laser radiation intensity, owing to absorption from the excited state. Structural chemical formulas and methods of preparation are given. Figures 5, tables 2, references 12: 4 Russian, 8 Western. [166-2415]

UDC 621.373.826.038.823

#### FEASIBILITY OF CONTINUOUS-WAVE CHEMICAL OH-LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 11 Mar 83) pp 97-102

BAYKOV, E. U., BASHKIN, A. S., NESHCHIMENKO, Yu. P., ORAYEVSKIY, A. N. and YURYSHEV, N. N., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The feasibility of a continuous-wave chemical laser based on the highly exothermic reaction  $\text{H} + \text{O}_3 = \text{OH}(\nu) + \text{O}_2 - \Delta H = 78 \text{ kcal/mole}$  with non-toxic products is examined from the standpoint of further improving its efficiency. Only a  $\text{D}(\text{H})-\text{O}_3-\text{CO}_2$  laser with efficiency up to 18% has so far been made on this basis. All fundamental elementary processes in an OH-laser are taken into consideration, especially those that have not yet been thoroughly explored. The latter include V-T relaxation of OH and OD radicals. Calculations are done for a simple mathematical model that admits an analytical solution. The corresponding kinetic equations are solved for the two extreme cases of  $[\text{H}] \gg [\text{O}_3]$  and  $[\text{H}] \ll [\text{O}_3]$  so that depletion of atomic hydrogen or of ozone, respectively, can be disregarded. The populations of the lower and upper vibrational levels are found from the concentrations of reagents and the OH radical as functions of time. Next the gain is calculated, also as a function of time, and its maximum is found as well as the cross-section of induced transition of the OH radical. While this reaction is not expected to yield a high-efficiency pulse laser, inasmuch as it is not a chain reaction, estimates indicate that an efficient continuous-wave laser is feasible as long as the inversion time is not shorter than the characteristic mixing time of 20-40  $\mu\text{s}$ . The requirement is that  $[\text{H}_2] + [\text{H}] \leq (2.5-5) \cdot 10^{16} \text{ cm}^{-3}$  in the  $[\text{H}] \gg [\text{O}_3]$  case and  $[\text{O}_3] \approx 5 \cdot 10^{15} \text{ cm}^{-3}$  in the  $[\text{H}] \ll [\text{O}_3]$  case. This yields a gain  $\alpha \approx 12 \text{ m}^{-1}$  for  $[\text{H}] = 3 [\text{O}_3] = 3 \cdot 10^{16} \text{ cm}^{-3}$  and  $\alpha \approx 1.5 \text{ m}^{-1}$  for

$[O_3] = 3 [H]$ , based on  $[H_2] : [H]$  ratios as those in an  $H-O_3-CO_2$  laser. The intermediate range of more comparable  $[H]$  and  $[O_3]$  concentrations needs to be further studied. References 6: 4 Russian, 2 Western.  
[166-2415]

UDC 621.373:826.038.84

#### UTILIZATION OF TRANSFER OF ELECTRON EXCITATION ENERGY IN ACTIVE MEDIA OF DYE LASERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 25 Feb 83) pp 77-80

RODCHENKOVA, V. V., REVA, M. G., AKIMOV, A. I. and UZHINOV, B. M., Moscow State University imeni M. V. Lomonosov

[Abstract] The feasibility of improving the performance of dye lasers by utilizing the transfer of electron energy in two-component active mixtures was studied in an experiment with acriflavine or coumarin 7 as energy acceptor and coumarin 1, 102, or 120 as energy donor. The active mixture was excited with transverse second-harmonic pumping by a monopulse ruby laser ( $\lambda = 347$  nm). The luminescence and emission spectra of each donor-acceptor pair were measured over a wide range of concentrations. The results indicate that the efficiency of laser emission is higher upon excitation of acriflavine in mixture rather than alone. Utilization of the energy transfer also widens the spectral range of such a dye laser owing to overlapping of the spectra of the two components mixed in certain ratios. Figures 3, tables 2, references 5: 1 Russian, 4 Western.  
[166-2415]

UDC 621.373.826.038.825.4

#### COHERENCE AND SPECTRAL CHARACTERISTICS OF RADIATION FROM SEMICONDUCTOR LASER WITH EXTERNAL MIRROR

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 6 Dec 82, after revision 23 May 83) pp 35-43

SURIS, R. A. and TAGER, A. A., Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow

[Abstract] The effect of an external mirror on the characteristics of a semiconductor injection laser is analyzed theoretically. Of particular interest are the coherence and the dynamics of emission. The conditions for emission are established for a single-mode laser with optical coupling to an external mirror, the latter being any radiation scattering object such as a waveguide edge or matching lenses. The degree of coherence in a gaussian beam is calculated from the corresponding Langevin differential-difference equation for phase fluctuation noise, with the nonlinear term disregarded. The essential



parameters in the system are  $\theta = k\tau / \tau_0$  and  $Nk$  ( $k$  - coupling coefficient,  $\tau$  - photon transit time to mirror and back,  $\tau_0$  - photon transit time through active medium,  $N$  - order of magnitude of number of emission quanta in active region). The radiation spectrum and its dependence on the pumping current are calculated from the Fourier transform of the coherence function. The results reveal that an external mirror will influence the laser radiation coherence only when  $\theta \gtrsim 1$  and  $Nk \gg 1$  and that the emission line can become slightly narrower or much wider when  $\theta \approx 1$ , while the coherence time of the laser alone is much longer than the photon transit time to the mirror. With the distance to the mirror fixed, the laser spectrum depends strongly on the pumping current. When this distance is much longer than the coherence path of the laser alone, then the radiation spectrum becomes multimodal. Figures 4, references 18: 7 Russian, 11 Western.  
[166-2415]

UDC 621.373.826

#### DOES A LASER GENERATE COHERENT RADIATION?

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 2 Jun 83) pp 31-35

AMEL'KIN, S. V., ARKHANGEL'SKIY, N. B. and ORAYEVSKIY, A. N., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Recent reports about the existence of a laser emission mode that has no classical analogue seem to suggest that a laser perhaps does not generate coherent radiation but only converts it. Here the reasons for such a paradoxical conclusion are examined on the simple Dicke model of  $N$  two-level atoms and a field with linear dimensions  $d \lesssim \lambda/2$  ( $\lambda$  - wavelength). An evaluation of its Hamiltonian with a desymmetrizing perturbation term added on the basis of group theory and an analysis of solvents the Fokker-Planck equation on the basis of quantum theory as well as the fluctuation-dissipation theorem for both steady and transient states indicate that polarization by the pumping source is not a necessary condition for coherence, since it is almost unattainable anyway. While specific quantum characteristics of a laser field are manifested in processes that have no physical analogues in classical theory, quantum analysis of such processes that contributes nothing new beyond classical analysis. Figures 2, references 12: 10 Russian, 2 Western.  
[166-2415]



DISSOCIATION KINETICS OF DIATOMIC MOLECULES DURING LASER EXCITATION OF LOWER VIBRATIONAL LEVELS AND EFFICIENT HEAT REMOVAL

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 3 FIZIKA ASTRONOMIYA in Russian Vol 25, No 1, Jan-Feb 84 (manuscript received 22 Jun 83) pp 97-100

GREBENYUK, S. G. and OSIPOV, A. I., Department of Molecular Physics

[Abstract] The influence of the initial conditions and parameters of the laser pulse on the molecule dissociation process is examined using an isothermal system of harmonic oscillators as an example. A system of equations describing the process of dissociation of diatomic molecules in many-quantum absorption of laser radiation is solved by computer for fast VV-exchange and high rates of collisional transitions to the continuous spectrum. An exponential pulse is shown to be most effective for achieving steady state-behavior in the system. This is because vibrational degrees of freedom are initially "heated", which is then sustained by the extended but weaker radiation in the tail of the pulse. The use of exponential pumping pulses makes it possible to achieve a high yield of reaction products at low temperatures economically. Figures 3, references 3 Russian.  
[193-6900]

UDC 539.18

COMPARATIVE ANALYSIS OF RADIATION DURING CHANNELING AND RADIATION IN MICRO-  
AND MACRO-UNDULATORS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 273, No 4, Dec 83  
(manuscript received 10 May 83) pp 849-851

GEVORGYAN, L. A. and KORKHMAZYAN, N. A., Yerevan Physical Institute,  
Armenian State Pedagogical Institute

[Abstract] Erroneous assertions due to the lack of a detailed analysis of the relationships between radiation occurring during channeling and during radiation in undulators in two recent studies are identified and corrected. Macro-undulators are found to be the most efficient radiation sources in the ultraviolet region; the Kumakhov method remains unchallenged with respect to the generation of harder quanta, especially gamma radiation. References 9 Russian.  
[251-6900]

UDC 666.112:546.18

NONLINEARITY OF INDEX OF REFRACTION OF FLUOROPHOSPHATE GLASS

Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 9, No 3, May-Jun 83  
(manuscript received 26 Feb 82) pp 325-328

GALANT, V. Ye., PETROVSKIY, G. T. and URUSOVSKAYA, L. N., State Optical  
Institute imeni S. I. Vavilov

[Abstract] The influence of various fluorides on the coefficient of non-linearity of the index of refraction of  $\text{Al}(\text{PO}_3)_3\text{-BaF}_2\text{-AlF}_3$  fluorophosphate glasses is studied. Fluorides of the elements of periodic system groups I, II and III were added to this base. Most of the optical constants were measured on a 5-second goniometer. The smallest coefficients are obtained in glasses containing fluorides with elements with low electron polarizability -  $\text{AlF}_3$ ,  $\text{MgF}_2$ ,  $\text{LiF}$  and  $\text{NaF}$ . Figures 2, references 6: 4 Russian, 2 Western.  
[194-6900]

## RECOGNITION OF NATURAL FORMATIONS BY COLOR AND CHROMINANCE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 273, No 4, Dec 83  
(manuscript received 21 May 83) pp 854-857

KISELEVSKIY, L. I., academician, Belorussian SSR Academy of Sciences,  
KOVALEV, A. A. and PLYUTA, V. Ye., Institute of Physics, Belorussian SSR  
Academy of Sciences

[Abstract] Some findings on the recognition of natural formations by their color and chrominance from the upper boundary of the atmosphere are presented. Spectral data obtained from the Salyut-4 station using an MSS-2 spectrometer are analyzed. Color is determined quantitatively by color coordinates in three-dimensional color space; natural formations are recognized in color spaces. The possibility of classifying objects by their chrominance is assessed. The objects investigated included green vegetation, deserts, bodies of water and dense clouds. It is found that the underlying surface can be recognized quite reliably from color characteristics measured from space. References 9 Russian.  
[251-6900]

## TRANSIENT THERMAL LENS FORMED BY SHORT LASER PULSE IN CONDENSED MEDIA

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 45, No 6, Dec 83  
(manuscript received 20 Sep 82) pp 983-987

BRUK-LEVINSON, E. T., PLOKHOTSKI, Z. and KHODAN, I. V., Institute of Heat and Mass Exchange imeni A. V. Lykov, Belorussian SSR Academy of Sciences, and Institute of Fundamental Problems of Engineering, Polish Academy of Sciences

[Abstract] An investigation is made of the thermal lens formed when a short high-power laser pulse is passed through a thin layer of matter. The relationship between the thermophysical properties of the matter, the spatial and temporal behavior of the index of refraction and the optical characteristics of the lens is established. The focal length of the lens increases without limit over time. An asymptotic expression for the focal length as  $\tau \rightarrow \infty$  is presented. Figures 2, references 5 Russian.  
[172-6900]

## RADIAL LENSES

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 3,  
12 Feb 84 (manuscript received 7 Jul 83) pp 183-186

YAVOR, S. Ya.

[Abstract] A new class of lenses is examined for which the potential distribution is independent of the radius vector in a spherical coordinate system and in which the axial beam trajectory coincides with the radius vector. These radial lenses are similar in many respects to quadrupoles in that they scatter particles in one plane while gathering them in another. A field model analogous to the rectangular model can be used to determine the optical properties of radial lenses. An expression is given for the focal length and focus position in a radial lens. References 2 Russian.  
[198-6900]

## DEPTH MICROSTRUCTURE OF IMAGE FORMED BY CORNER REFLECTOR

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 3,  
12 Feb 84 (manuscript received 20 Nov 83) pp 176-179

KORNEYEV, V. I.

[Abstract] The resolution of an ideal corner reflector employing total internal reflection is found to be half that of an ideal flat reflector of the same shape and diameter. When a corner reflector is used three images with practically the same contrast are formed along the optical axis, in contrast to an ideal flat reflector which forms a single image of the sinusoidal amplitude grating in the focal plane. As the orientation of the corner reflector changes, the quality of the image remains approximately the same, but the corresponding images move along the optical axis with respect to their original positions. The mechanism underlying the formation of the image of a complex test object is discussed. It is noted that different spatial frequencies focus in different planes that do not coincide with the plane of maximum contrast for frequency  $\nu = 0.2$ . Figures 2, references 2: 2: 1 Russian, 1 Western.  
[198-6900]

## SUPPRESSION OF INTERFERENCE EFFECTS DURING MULTIPLE SCATTERING OF LIGHT

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 84,  
No 1, Jan 84 (manuscript received 12 May 83) pp 47-59

GOLUBENTSEV, A. A., Institute of Theoretical Physics imeni L. D. Landau,  
USSR Academy of Sciences

[Abstract] The influence of chaotic movement of heterogeneities of the index of refraction of the medium and gyrotropy of the medium caused by an external

magnetic field due to the Faraday effect on interference effects occurring during multiple scattering is examined. The behavior of the scattering cross section as a function of these factors is analyzed, including the influence of movement of heterogeneities on backscattering amplification. Figures 4, references 16: 14 Russian, 2 Western.  
[190-6900]

INFLUENCE OF VARYING TRANSPARENCY ON CONVECTIVE INSTABILITY AND SELF-FOCUSING INITIATED BY OPTICAL AND MICROWAVE RADIATION IN LIQUID, GAS AND SOLID.  
PRE-BREAKDOWN PHENOMENA

Leningrad ZHURNAL TEKHNIЧЕСКИЙ ФИЗИКИ in Russian Vol 53, No 11, Nov 83  
(manuscript received 17 Sep 82) pp 2113-2118

GALICH, N. Ye., Leningrad Polytechnical Institute imeni M. I. Kalinin

[Abstract] The thermal interaction of electromagnetic radiation and a weakly absorbing medium--liquid, gas and solid dielectric semiconductors--is examined with respect to the temperature behavior of the density, index of refraction and coefficient of absorption of radiation. A description is given of the aforementioned nonlinear effects occurring simultaneously under different conditions of interaction between the radiation and the substance. Thresholds are estimated and the characteristic parameters are presented. The occurrence of convective instability in liquids and gases with constant and varying transparency is investigated. Nonlinear refraction, nonlinear absorption of radiation and pre-breakdown phenomena are examined in solids, as well as liquids and gases subsequent to the development of convection. References 14 Russian.  
[146-6900]

UDC 535.36

BRIGHTNESS OF SPHERICAL SCATTERING OBJECT

Minsk VESTSI AKADEMII NAVUK BSSR: SERIYA FIZIKA-MATEMATYCHNYKH NAVUK in Russian No 2, Mar-Apr 84 (manuscript received 10 Jun 83) pp 57-60

IVANOV, A. P., GAVRILOVICH, A. B. and BORISEVICH, M. N., Institute of Physics, Belorussian SSR Academy of Sciences

[Abstract] The brightness distribution over the surface of a spherical light scattering object illuminated by a parallel radiant beam is modeled experimentally. The optical path, single scattering albedo and observation conditions were varied for non-absorbing spheres. The influence of absorption on the relationship between the brightness of the measured point and the incident light flux is analyzed. Figures 3, references 1 Russian.  
[253-6900]



## THEORY OF ACOUSTOOPTICAL INTERACTION IN OPTICALLY ISOTROPIC MEDIA

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 45, No 2, Feb 84  
(manuscript received 18 Aug 81) pp 296-302

ZADORIN, A. S.

[Abstract] The functional relationship is established between the efficiency and polarization of diffracted light and the polarization of incident light. The extrema of these functions are found, along with their corresponding vector directions. At least two mutually orthogonal directions are established for the polarization vector of incident light for which the light has the same polarization in all diffraction orders and for which the coupling between adjacent orders is extremal. Diffraction efficiency is maximum if the polarization of the incident light wave coincides with the eigenvector of the tensor  $\delta \epsilon_n$  that corresponds to the eigenvalue  $\lambda_0$  with the greatest absolute value. The coupling between diffraction orders with high numbers  $j$  is near-maximum and depends little upon the polarization stage of the incident light. References 8 Russian.  
[207-6900]

UDC 535.31:681.7.53.082.5

## FOCUSERS OF OBLIQUELY INCIDENT LASER RADIATION

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 11 Jul 83) pp 166-168

GONCHARSKIY, A. V., DANILOV, V. A., POPOV, V. V., PROKHOROV, A. M.,  
SISAKYAN, I. N., SAYFER, V. A. and STEPANOV, V. V., Institute of General  
Physics, USSR Academy of Sciences, Moscow

[Abstract] The problem of focusing obliquely incident laser radiation along a given line in space with a given intensity distribution is treated as a problem of synthesizing a mirror surface that will achieve this. The necessarily intricate shape of such a surface, characterized by a function  $z = z(u, v)$  in the approximation of geometrical optics, is determined from the equation  $\Phi(u, v, z) - \Phi_0(u, v, z) = 0$ , expressing that the incident field and the reflected field have identical eikonals. Further calculations are facilitated by replacing continuous mirror with a more easily manufactured piecewise-continuous (smooth) one. The problem is then solved for the simple case of a plane incident wave with a typical iconal  $\Phi_0(u, v, z) = -z \cos \theta$  at a large angle to a focus mirror in the  $z$ -plane region. Mirrors constructed on the basis of the theoretical solution were tested in an experiment with a  $\text{CO}_2$ -laser. A light beam with gaussian intensity distribution could, upon incidence at a  $45^\circ$  angle, be focused into a circle or into an ellipse with uniform intensity distribution. Improvements in amplitudinal masking and selective tanning technology should reduce energy losses at the surface and thus result in efficient laser focusing mirrors. Figures 2, references 5 Russian.  
[166-2415]

## EPR AND OPTICAL ABSORPTION SPECTRA IN GERMANATE GLASSES

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR: SERIYA FIZICHESKIKH I  
TEKHNICHESKIKH NAUK in Russian No 1, Jan-Feb 84 (manuscript received 2 Jul 83)  
pp 36-40

KLYAVA, Ya. G., KUTUKOVA, Ye. S., MIRONOVA, N. A., SEGAL, N. G., SKVORTSOVA,  
V. N. and CHUGUNOV, L. A., Latvian State University imeni P. Stuchka;  
Scientific Research Institute of Solid State Physics, Latvian State University  
imeni P. Stuchka; Institute of Physics, LaSSR

[Abstract]  $Gd^{3+}$  activator centers in glass are studied by methods of electron paramagnetic resonance and optical absorption. The measurements were done on germanium silicate glasses with different gadolinium concentrations. Sodium and lithium were added as carbonates and nitrates, with the concentration of trivalent gadolinium in the former case being much greater. Absorption spectra were measured on the Specord-UV-VIS spectrometer in the 12,500-50,000  $cm^{-1}$  wavelength range, and the EPR spectra were measured with a homodyne spectrometer with frequency modulation of 100 kHz in the 3-cm band. The measurements were made at room temperature. The observed spectra were analyzed with consideration of the orientational and compositional disorder of glass. Analysis of the optical absorption spectra implies that symmetry of the  $Gd^{3+}$  environment is rhombic or lower. The EPR spectra are typical of those for  $Gd^{3+}$  in various disordered solids. All major features of the EPR spectra can be described with satisfactory accuracy by assuming a single type of  $Gd^{3+}$  center via the spin-hamiltonian of orthorhombic symmetry with distributed fine structure parameters. This interpretation explains the identity of the form of spectrum in different glasses and adequately accounts for the disorder of the glass structure. The gadolinium environment in these glasses with low  $Gd_2O_3$  concentrations is characterized by strong distortion. Figures 4, references 15: 8 Russian, 1 Hungarian, 6 Western.  
[202-6610]

## TECHNIQUE FOR EXPERIMENTAL INVESTIGATION OF OPTICAL CHARACTERISTICS OF REFRACTORY MATERIALS AT ULTRAHIGH TEMPERATURES

Mosc. TEPILOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 22, No 1, Jan-Feb 84  
(manuscript received 18 Mar 83) pp 131-137

BASILARIN, A. Yu., KIRILLIN, A. V. and SHEYNDLIN, M. A., Institute of High  
Temperatures, USSR Academy of Sciences

[Abstract] A method is developed for studying the reflective and radiative characteristics of refractory materials at temperatures in excess of 4000 K. The technique is based on reflectometry of the surface of a specimen heated by a cw  $CO_2$  laser in a laser photometer with integrating sphere. The major

components of a high-speed automated experimental facility are described. Tentative data are given on emittance at a wavelength of  $0.63\text{ }\mu\text{m}$  as a function of temperature for the surface of pyrolytically precipitated graphite at temperatures up to 4000 K. The results show that the emittance of the subliming surface depends only on the state of the surface. Figures 4, references 4: 3 Russian, 1 Western.  
[201-6610]

UDC 536.3:535.36:535.33

#### CALCULATING INFRARED RADIATION OF GAS-DUST SCATTERING MEDIUM

Moscow TEPILOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 22, No 1, Jan-Feb 84  
(manuscript received 20 Oct 82) pp 95-98

POPOV, Yu. A., All-Union Scientific Research Institute of Metallurgical Technology, Sverdlovsk

[Abstract] The author determines the reflectivity of a semi-infinite gas-dust layer in the quasi-one-dimensional approximation where it is sufficient to solve the problem for a spherical scattering indicatrix. The probability density function is found for photons with respect to the product of the path length of a ray multiplied by the extinction factor of particles. The expression is simplified by carrying out Laplace transformation by the Widder method. It is assumed that the law of absorption of radiation by the gas-dust medium corresponds to Goody's statistical model. It is demonstrated by the example of the  $4.3\text{ }\mu\text{m}$  band of  $\text{CO}_2$  that when the particle extinction factor is greater than  $1\text{ m}^{-1}$ , particles may have an appreciable effect on thermal radiation in the prescribed spectral interval. This fact must be taken into consideration when measuring temperature with respect to infrared radiation in bands of dusty gas. Results of reflectivity calculations are given for different parameters of the statistical model of the bands, and for different probabilities of photon survival with scattering by particles of the medium. Tables 2, references 12 Russian.  
[201-6610]

UDC 537.876.23:551.510.5

#### EFFICIENCY OF FOCUSING PHASE-CONJUGATE WAVE FIELD IN TURBULENT ATMOSPHERE IN PRESENCE OF WIND

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 29, No 1, Jan 84  
(manuscript received 16 Aug 82) pp 1-4

AKHUNOV, Kh. G., BUNKIN, F. V., VLASOV, D. V. and KRAVTSOV, Yu. A.

[Abstract] The authors analyze the efficiency of focusing a phase-conjugate field in a turbulent atmosphere with displacements of heterogeneities that are not limited by the internal scale of turbulence. It is assumed that the

field is the result of phase-conjugate reflection of a wave emanating from a unit source, with the field incident on the phase-conjugate mirror being described by a stochastic Green's function corresponding to monochromatic radiation. It is assumed that the source is in motion and that atmospheric heterogeneities drift at wind speed. It is shown that the efficiency of phase conjugation is determined by the minimum of the quantities  $\vec{P}_a$  and  $|\vec{P}_b - \vec{P}_v|$ , where  $\vec{P}_a$  is the aperture radius of the phase-conjugate mirror,  $\vec{P}_b = \vec{u}(2L/c)$  is the displacement of the source during a round trip of the wave,  $\vec{P}_v = \vec{v}(2l/c)$  is the drift of heterogeneities for the same time period. These distances are normalized to the coherence radius of a spherical wave. Numerical estimates show that the influence of turbulent fluctuations on conjugation efficiency can be disregarded up to distances of about 1 km. It is shown that under certain conditions the source can be moved so as to completely cancel phase distortions due to wind drift. Figures 2, references 4 Russian.

[142-6610]

UDC 666.11.01

FIBER OPTIC LIGHT GUIDES BASED ON POLYMER-COATED MULTICOMPONENT GLASSES

Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 9, No 3 May-Jun 83  
(manuscript received 17 Sep 82) pp 371-373

GRIGOR'YANTS, V. V., DETINICH, V. A., IZYNEYEV, A. A., KRAVCHENKO, V. B.,  
MINKOVICH, V. P. and CHAMOROVSKIY, Yu. K., Institute of Electrical Engineering  
and Electronics, USSR Academy of Sciences

[Abstract] The findings from obtaining and investigating the properties of polymer-coated fibers made from blanks drawn from a melt of multicomponent glass are presented. The method by which the "glass-polymer" light guides were drawn is not described. The light reflecting coating was a organosilicon compound (elastic siloxane). Optical loss measurements indicated that attenuation is heavily dependent on the conditions under which the glass is heated. The minimum losses at  $0.85 \mu\text{m}$  were 50-75 dB/km. The method can be used to produce fiber optic light guides with moderate losses and to control the total amount of impurities in chemical reagents employed in fiber optics. References 7: 5 Russian, 2 Western.  
[194-6900]

UDC 535.416.3

CONTROLLING WAVEFRONT OF OPTICAL RADIATION PROPAGATING IN MEDIUM MOVING AT VARIABLE VELOCITY

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 3 FIZIKA ASTRONOMIYA in Russian Vol 25, No 1, Jan-Feb 84 (manuscript received 14 Jul 83) pp 105-108

TROFIMOV, V. A., Department of Computational Methods, Faculty of Computational Mathematics and Sibernetics

[Abstract] The effectiveness of controlling the wavefront of optical radiation passing through a thin layer of a medium moving at varying velocities is examined. The conditions required for stable operation of the system are discussed. An example is given for linear (increasing and decreasing) and exponential wind speed profiles. References 5 Russian.  
[193-6900]



## PRIZ TYPE SPACE-TIME LIGHT MODULATOR WITH ENHANCED SENSITIVITY

Novosibirsk AVTOMETRIYA in Russian No 1, Jan-Feb 84 (manuscript received 16 Sep 83) pp 108-109

GUSEV, V. A., DEMENKO, S. I., DETINENKO, V. A. and MALINOVSKIY, V. K.

[Abstract] The findings from investigations of PRIZ-type space-time light modulators with enhanced sensitivity through recording radiation ( $\lambda=400-500$  nm) are presented. The studies were performed on modulators based on  $\text{Bi}_{12}\text{SiO}_{20}$  single crystals 1 mm thick; the modulator employed the transmission principle. The resolution of a modulator based on tin-doped  $\text{Bi}_{12}\text{SiO}_{20}$  single crystals provided resolution of better than 50 lines per millimeter, a dynamic range of 51 dB, an unrestricted number of write-erase cycles, and a sensitivity of  $8 \cdot 10^{-8}$  J/cm<sup>2</sup> at a recording wavelength of  $\lambda=436$  nm. Figures 4, references 2 Russian.  
[242-6900]

UDC 551.501.71

## CHARACTERISTICS OF LIDAR SIGNAL PROCESSING DURING MEASUREMENT OF GASEOUS ATMOSPHERIC IMPURITIES

Novosibirsk AVTOMETRIYA in Russian No 1, Jan-Feb 84 (manuscript received 3 Jun 83) pp 92-97

ASTAFUROV, V. G. and MITSEL', A. A.

[Abstract] The processing of lidar signals obtained by differential absorption in the photon-counting mode is examined. The plotting of estimates for the average lidar signal power inside and outside of the absorption line in the photon counting mode is explained; recovery of the gas concentration profile and humidity profile is discussed. It is shown that allowance must be made for the inertia of the recording apparatus and that the use of smoothing splines in the differential absorption method is effective. Figures 2, references 12 Russian.  
[242-6900]

## SCATTERING OF ATOMS BY FORCES OF STIMULATED LIGHT PRESSURE

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 86, No 1, Jan 84 (manuscript received 17 Jun 83) pp 100-109

GRINCHUK, V. A., KAZANTSEV, A. P., KUZIN, Ye. F., NAGAYEVA, M. L., RYABENKO, G. A., SURDUTOVICH, G. I. and YAKOVLEV, V. P., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The effects of stimulated light pressure are studied with respect to the scattering of a beam of Na atoms by a standing-wave laser pulse. The scattering picture is discussed theoretically, and the results of an experimental investigation of the scattering pattern and the relationship between the parameters of the field and the atom beam are presented. The experimental relationship between scattering efficiency and the magnitude of electrical field and detuning of the resonance is discussed. The atom scattering efficiency by a standing light wave pulse is of the order of unity in comparatively weak tunable laser fields. Figures 8, references 13: 7 Russian, 6 Western.  
[190-6900]

UDC 53:51

## METHOD FOR CALCULATING FIELD OF ELECTROOPTICAL SYSTEMS WITH STRUCTURE DESCRIBED IN DIFFERENT SCALES

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83 (manuscript received 27 Oct 82) pp 2274-2277

FREYNKMAN, B. G., All-Union Scientific Research Institute for Optical-Physical Measurements

[Abstract] A method is proposed that eliminates digitization difficulties in the case of electrooptical systems in which the elements are described in different scales by reducing the original problem to two different-scale problems. The solution of the initial different-scale problem is then reduced to the solution of two single-scale problems. The first problem is solved on the scale of the dimension of electrooptical system,  $L$ , disregarding the small-scale structure. The second problem uses the solution of the first problem on the scale  $\delta$  for a fragment of the small-scale structure. If the small-scale structure is non-local in nature, the solution of the second problem is presented in a form which is invariant to the position of the fragment of the structures. References 2 Russian.  
[146-6900]

## METHOD FOR CALCULATING INTEGRAL CHARACTERISTICS OF ELECTROOPTICAL SYSTEMS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 21 Jun 82) pp 2264-2266

FREYNKMAN, B. G., All-Union Scientific Research Institute for Optical-Physical Measurement

[Abstract] The integral characteristics of electrooptical systems are calculated, and their behavior is determined as a function of small variations in the geometric parameters of the electrooptical system. Examples are presented that demonstrate the possibility of calculating the tolerances for the geometric parameters on the basis of acceptable limits of variation of the integral characteristics. The computational process is accelerated significantly for multiparametric optimization of electrooptical system geometry. References 4 Russian.

[146-6900]

DYNAMIC RECORDING OF IMAGES IN  $\text{Bi}_{12}\text{SiO}_{20}$  CRYSTALS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 4 Mar 83) pp 2255-2257

STEPANOV, S. I. and KULIKOV, V. V., Physical-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] An effect analogous to the processes occurring in biological visual systems is investigated during optical recording in  $\text{Bi}_{12}\text{SiO}_{20}$  crystals with an electric field created via electrodes on the lateral facets of the specimen. The pulsed nature of the recording and the variation in contrast at the leading and trailing edges of the recording pulse are discussed. The temporal behavior of the intensity of diffraction of green light is described, as is that of current passing through a specimen continuously illuminated with green light with pulse exposure to homogeneous red light. Figures 2, references 7: 4 Russian, 3 Western.

[146-6900]

## EQUATIONS FOR PERTURBATION OF ELECTRON MOVEMENT IN THE EVENT OF SMALL VARIATIONS OF INITIAL CONDITIONS AND GEOMETRY OF ELECTRONIC-OPTICAL SYSTEMS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 21 Jun 82) pp 2119-2124

FREYNKMAN, B. G., All-Union Scientific Research Institute for Optical and Physical Measurements

[Abstract] The electron movement equation is derived in a stationary coordinate system with arbitrary perturbations of all initial conditions and the field.

The first- and second-order electron motion perturbation equations are found for flat and arbitrary emitting surfaces. The perturbation equations can be used to analyze wide electron beams, as well as individual trajectories. References 2 Russian.  
[146-6900]

UDC 772.932.45:621.373.826.038.825

USE OF RADIATION FROM PULSED SOLID-STATE LASERS FOR HOLOGRAPHIC RECORDING OF INFORMATION ON THERMOPLASTIC FILM

Minsk VESTSI AKADEMII NAVUK BSSR: SERYYA FIZIKA-MATIMATYCHNYKH NAVUK in Russian No 2, Mar-Apr 84 (manuscript received 15 Jul 82) pp 72-76

KOVALEV, A. A. and ZHDANOVICH, S. N., Institute of Electronics, Belorussian SSR Academy of Sciences

[Abstract] The possibility of reversible recording of homograms on thermoplastic photo materials using nanosecond pulses with high peak power is examined. The process by which the latent electrostatic image is formed within the structure of the thermoplastic medium is analyzed. A test rig for studying homogram recording is described. It is demonstrated that it is possible to record information holographically on thermoplastic media. Figures 4, references 4 Russian.  
[253-6900]

UDC 621.373.535:537.311.33

USE OF MULTIMODE SEMICONDUCTOR LASER IN FIBER OPTIC COMMUNICATIONS LINES WITH SPECTRAL MULTIPLEXING IN 0.9  $\mu$ m REGION

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 56, No 2, Feb 84 (manuscript received 24 Jun 81) pp 344-346

DERYUGIN, L. N., DEMCHENKOV, V. P., ZHELANKIN, O. G., PETRUS', A. A. and CHEKAN, A. V.

[Abstract] The possibility of constructing spectrally-multiplexed fiber optic communication lines employing a single multi-mode laser source is investigated experimentally. It is demonstrated that it is possible in principle to use a single wideband semiconductor laser in systems employing spectral multiplexing of the intelligence channels. Losses can be reduced by employing diffraction gratings with a large transfer coefficient by using coated optics and optimum matching of all of the optical elements of the system. References 5 Russian.  
[207-6900]

## FORMATION OF RADIO IMAGES DURING CIRCULAR SCANNING

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 28, No 2, Feb 84

(manuscript received 15 Apr 83) pp 123-126

BERLYACHITS, A. Ch., KUKHARCHIK, P. D., and SEMENCHIK, V. G., Scientific Research Institute of Applied Physics Problems imeni A. N. Sevchenko

[Abstract] The possibility of reproducing two-dimensional images of objects with satisfactory quality by using the principles of radio holography with a circular receiving aperture is demonstrated. A long-wave holographic system is examined; an expression for the uncertainty function of the system is derived and is found to be described by a zero-order Bessel function of the first kind. A circular aperture reduces the number of samples almost 40-fold as compared with a rectangular aperture. Computer modeling of the circular-aperture holographic system is described. Figures 2, references 3 Russian. [214-6900]

UDC 621.391

## USING INFORMATION ON TANGENTIAL TARGET MOTION IN SPACE-TIME SIGNAL PROCESSING

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 29, No 1, Jan 84

(manuscript received 5 Jul 82) pp 57-64

KREMER, I. Ya. and GERMAN, A. M.

[Abstract] In an earlier paper, these authors considered the description of a space-time signal scattered by a moving point target [RADIOTEKHNIKA I ELEKTRONIKA, Vol 27, No 4, 1982, p 721]. This description gives an idea of the potential for resolving moving targets, as well as the limits for improving the accuracy of measuring coordinates and velocities in active ranging against a background of set noises. Previous research has shown that the tangential (angular) displacement of a target relative to the reception antenna rotates the phase front and produces linear frequency modulation of the wave scattered by the target. In this paper, the authors consider the contribution of each of these factors to the potential capabilities of target resolution with respect to tangential (angular) velocity for various ratios between reception antenna size and target range. An estimate is made of the limiting accuracy of measuring tangential (angular) velocity of a target in active ranging against a background of equipment noise. Based on their earlier space-time description of signals in radar systems with synthesized apertures, the authors determine the contribution of the physical aperture to angular resolution and to the potential capabilities of measuring the angular coordinate of a target against interference. Figures 2, references 3 Russian.



# RECORDING GRATING STRUCTURE ON SURFACE OF OPTICALLY CONTROLLED WAVEGUIDE BASED ON $\text{CdS}_x\text{Se}_{1-x}$

Tbilisi SOOBASHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 3, No 2,  
Aug 83 (manuscript received 25 Jun 82) pp 277-278

BUACHIDZE, Z. E., KACHARAVA, G. P., MOROZOV, V. N., PLETNEV, V. A., SEMENOV,  
A. S. and CHIRAKADZE, A. A., Tbilisi State University

[Abstract] An investigation is made of the major characteristics of  $\text{CdS}_x\text{Se}_{1-x}$  waveguides produced by the Taylor-Martin method [H. F. Taylor, W. E. Martin, APPL. PHYS. LETT., Vol 21, 1975, p 95]. It is demonstrated that such waveguides are suitable for certain passive and active integrated-optics components. Gallium phosphide prisms (index of refraction  $n = 3.30$ ) were used to hook laser radiation ( $\lambda = 0.63 \mu\text{m}$ ) into and out of the waveguide. The mode composition of the waveguide was studied by a G-5 goniometer with resolution of  $10''$ . The index profile of the waveguide layer was calculated by the WKB method. The profile was reconstructed by a power-law approximation of  $n(z)$ . Results are shown for a waveguide in which 13 modes were excited. Depth of the diffusion layer was  $12 \mu\text{m}$ . On the waveguide surface,  $x = 0.9$ . Radiation losses on the  $0.63 \mu\text{m}$  wavelength were 9-13 dB/cm for different waveguides. To record a grating structure on the waveguide surface, a helium-cadmium laser ( $\lambda = 0.44 \mu\text{m}$ ) was used to project an interference pattern in the form of a set of parallel bands onto the surface. As the wavelength of the recording radiation lies in the region of absorption of the waveguide material, photochemical etching reproduces a relief diffraction grating on the surface. The profile of these structures was near-sinusoidal, the depth of the corrugation being linearly dependent on exposure time. The depth of the corrugation is also dependent on etching time and increases with decreasing selenium concentration. Gratings of this kind can be produced with a resolution of better than 1000 lines/mm. Figures 2.

[136-6610]

# PROPAGATION OF ULTRASHORT OPTICAL PULSES IN RESONANT NONLINEAR LIGHT GUIDES

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 85,  
No 4(10), Oct 83 (manuscript received 28 Jan 83)

MAYMISTOV, A. I. and MANYKIN, E. A., Moscow Engineering Physics Institute

[Abstract] The authors consider the influence that resonant absorption in the mode of self-induced transparency has on the propagation of ultrashort light pulses in a Kerr type nonlinear medium. The analysis is based on the example of a single-mode light guide containing resonant impurities modeled by two-level atoms. It is shown that the presence of such impurities has an appreciable effect on the condition of ultrashort pulse propagation as a soliton. As a result, the evolution of the pulse is described by generalized

Maxwell-Bloch equations. The formation of optical solitons, like the mode of self-induced transparency, is possible only when a certain ratio is reached between the frequency of the light wave and the parameters of the nonlinear medium. References 14: 7 Russian, 7 Western.

[188-6610]

## PLASMA PHYSICS

### CONVERSION OF GLOW DISCHARGE TO ARC DISCHARGE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 1 Mar 84 p 4

[Article by G. Sidorova: "When Electrons are in a Trap"]

[Text] "To make a discovery, it is not enough to find an unknown phenomenon--one must also prove its special nature," thus Aleksandr Ivanovich Nastyukha began the conversation. "For example, at first we simply did not believe it. We looked at the readings of the instruments and invited experiments. But even our friends doubted it 'this cannot be.' But it turned out that the effect which we discovered initially found practical application. And only then was it recognized as a discovery."

"The Phenomenon of Independent Direct Conversion of a Glow Discharge with Potential Traps for Electrons to an Arc Discharge," is the title of this paper, which was entered in the State Register of Discoveries under No 286. Its authors are scientists of the Institute of Atomic Energy imeni I. V. Kurchatov, Doctor of Physicomathematical Sciences A. Nastyukha and Candidate of Physicomathematical Sciences Ye. Koltypin.

"Everyone knows that the electric arc is used not only in welding or let us say in fluorescent lamps," A. Nastyukha says. "Metal in furnaces is melted and many processes in chemistry are performed by using it. Special devices of the gazotron and ignitron type are developed on the basis of its properties--like semiconductors, they transmit current in only one direction. The complexity is that semiconductors are designed for currents of tens of amperes and ignitrons are designed for a maximum up to 3,000 amperes. But we needed devices capable of creating pulsed currents with intensity of tens of thousands of amperes."

When investigations on controlled thermonuclear fusion were begun, researchers of the department headed by Academician I. Kikoin were included in them. An electric arc can be used to produce a plasma with superhigh temperatures. But gazotrons and ignitrons are unsuitable for the enormous currents required by investigators--they quickly failed. We had to develop a new device--the commutator, which can rectify currents upon to 100,000 amperes in intensity. And this is where scientists discovered an unusual phenomenon.

"It is not so simple to ignite an arc as it seems at first glance," Ye. Koltypin continued this story. "A so-called glow discharge first flares up between the electrodes. And it then converts to an arc discharge. But it may also not be converted--nature has erected a real barrier. To overcome this barrier, the voltage on the electrodes had to be increased appreciably. But at low pressures and even in a vacuum, this extravagant measure did not eliminate the difficulties. The glow discharge in our commutator, even at very low pressures, was converted to an arc discharge as if there were no barrier at all."

"Why then did your colleagues not believe your statements?"

"The fact is that the barrier could be overcome, there is no doubt of that. They did not believe the other phenomenon--that some previously unknown phenomenon was the basis of the commutator. But this did not interfere with our device attracting the attention of many specialists."

The first partners of the authors of the discovery were Novosibirsk physicists. Two new commutators replaced 72 ignitrons in their installation.

Industrial specialists followed the physicists. To stamp parts from "capricious" metals and alloys--up to brittle tungsten--it was decided to use powerful pulsed magnetic fields. New commutators were also required to create them. It then turned out that copper can be welded to aluminum, for example, with the participation of these devices, which cannot be welded by ordinary methods. And new methods of seismic prospecting followed cold welding. The electric explosion was an irreplaceable means for finding minerals on the continental shelf. But to find them, geophysicists needed devices capable of producing large currents.

Scientists relate that commutators and commutator units can be created for currents of more than one million amperes on the basis of the phenomenon which they discovered. And we again return to the question: What helps to ignite an arc under those conditions when it should not occur? What is the physical nature of the discovered phenomenon?

"We talked about a barrier in the path of a glow discharge to an arc discharge," answers A. Nastyukha. "But as it turned out, there are forms of glow discharges in which a kind of electron trap occurs in the space between the electrodes. 'Trapped' in it, they efficiently expend their energy on ionization of the gas. The barrier disappears as a result. And the electric arc is formed without hindrance."

The significance of the discovered is not exhausted by current areas of application. Specialists state that it will become one of the bridges, similar to semiconductor theory, on the path toward an essentially new technology--heavy current electronics of the 21st century.

6521  
CSO: 1862/184

UDC 537.523

PULSE VOLUME DISCHARGE WITH PLASMA CATHODE IN HIGH PRESSURE MOLECULAR GASES.  
II. DISCHARGE WITH IONIZATION MULTIPLICATION OF PHOTOELECTRONS. GENERATION  
OF RADIATION

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 11, Nov 83  
(manuscript received 10 Aug 82) pp 2138-2142

BYCHKOV, Yu. I., ZAROSLOV, D. Yu., KARLOV, N. V., KUZ'MIN, G. P., MESYATS,  
G. A., OSIPOV, V. V., PROKHOROV, A. M. and TEL'NOV, V. A., Physics Institute  
imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The energy and central characteristics of a powerful volume discharge are examined when the concentration of electrons created during preliminary ionization of a gaseous medium is approximately  $10^{11} \text{ cm}^{-3}$ , and the concentration is increased further by ionization multiplication. The studies were performed on apparatus incorporating a spark gap between the anode and energy accumulator. The average electron concentration in the discharge is determined for different field intensity--pressure combinations, making it possible to distinguish between a non-self-sustaining discharge and one with ionization multiplication of electrons. The electron concentration can increase nearly 100-fold due to ionization amplification for voltages below the static breakdown level. Good stability of volume pulse discharge with a plasma cathode is demonstrated; the method is shown to be suitable for exciting a gaseous medium to pump carbon dioxide lasers. Figures 5, references 5: 3 Russian, 2 Western.  
[146-6900]

UDC 533.95

BREMSSTRAHLUNG FROM LONGITUDINAL PLASMA WAVES PRODUCED BY SUBTHERMAL ELECTRONS  
IN PLASMA

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: FIZIKA in Russian Vol 19,  
No 1, Jan-Feb 84 (manuscript received 4 Apr 83) pp 15-19

AKOPYAN, A. V., Institute of Radiophysics and Electronics, Armenian SSR  
Academy of Sciences

[Abstract] Bremsstrahlung from a longitudinal plasma wave (l-wave) created during collisions of nonequilibrium subthermal electrons with the ions of an



isotropic, homogeneous fully ionized plasma is examined. Expressions are derived for the probability and intensity of the radiation for the case of electron-ion pairwise collision. The problem of wave instability during collective retardation of a group of electrons on ions is discussed. Plasma waves with  $\lambda \geq 10^{-1}$  cm will grow within a characteristic time of  $\gamma^{-1} 10^{-2}$  s for a plasma temperature of approximately  $10^3$  eV, plasma and flux densities of  $n_p \sim 10^{15}$  cm $^{-3}$  and  $n_0 \sim 10^{10}$  cm $^{-3}$  and average flux velocity  $u \sim 10^8$  cm/s. References 7: 6 Russian, 1 Western. [263-6900]

UDC 621.378

# ENERGY CHARACTERISTICS OF PLASMA GENERATED IN AIR NEAR TARGET BY RADIATION FROM CO<sub>2</sub>-LASER

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 5(141), Sep-Oct 83 (manuscript received 30 Apr 82) pp 3-7

DOLGOV-SAVEL'YEV, G. G., ZHUK, V. A., ORISHICH, A. M., PONOMARENKO, A. G., POSUKH, V. G. and SNYTIKOV, V. N., Novosibirsk

[Abstract] Experimental studies of plasma generated in cold air around a target by laser radiation involve measuring the energy absorbed by such a plasma following interaction of the laser beam and the target material. In one experiment an LG-75 CO<sub>2</sub>-laser ( $\lambda = 0.63$   $\mu$ m) was used as energy source in an LUI-2 amplifier configuration, with a diaphragm forming a square beam of 9.2x92 cm cross section and extracting a single transverse mode. Targets with a low reflection coefficient for radiation at the  $\lambda = 10.6$   $\mu$ m wavelength (graphite 0.2 and anodized aluminum 0.04) were placed at one end of a tubular chamber made of polished acrylic plastic sufficiently long for forming a one-dimensional gas flow, with the laser beam entering at the other end. The plasma energy was determined from measurements of the parameters of the subsonic radiation wave and the subsequent shock wave inside the chamber, in accordance with applicable laws of gas dynamics and theory of point explosion. Assuming an adiabatic process of plasma expansion and a shock wave whose energy is equal to the work done by the plasma layer in moving and expanding, there exists a threshold of total radiation energy below which the shock wave will not be stable and the readings become inaccurate with wide scatter. This threshold was found to be approximately 4.5 j/cm<sup>2</sup>, and above it a target that absorbs laser radiation at the  $\lambda = 10.6$   $\mu$ m wavelength was found to be an efficient converter of radiation energy to shock wave energy under radiation pulses of 0.8  $\mu$ s duration and  $3 \cdot 10^6$ - $1.5 \cdot 10^7$  W/cm<sup>2</sup> intensity. Figures 4, references 18: 17 Russian, 1 Western. [205-2415]

## MECHANISMS OF INSTABILITY OF HIGH-CURRENT DIRECT DISCHARGE UNDER LOW GAS PRESSURE

Moscow FIZIKI PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 16 Feb 82) pp 151-164

LUTSENKO, Ye. I., SEREDA, N. D. and DIMITROVA, V. D., Kharkov State University

[Abstract] An experimental study was made for the purpose of exploring the dynamics of high-current direct discharge under low pressure and the mechanisms of instability characterized by localization of electric field and electrical resistance. Measurements were made in highly ionized plasma ( $n \sim 10^{12-5} \cdot 10^{13} \text{ cm}^{-3}$ ,  $T_e \sim 10 \text{ eV}$ ,  $d \sim 3 \text{ cm}$ ) inside a glass tube ( $L \sim 100 \text{ cm}$ ,  $D \sim 12 \text{ cm}$ ) produced by injection of an electron beam under residual gas pressure ( $p \sim 5 \cdot 10^{-5} - 10^{-3} \text{ torr}$ ) parallel to a uniform magnetic field ( $H \sim 2 \text{ kOe}$ ). High-current discharge was excited, after injection, by application of a voltage ( $V_0 \sim 0-20 \text{ kV}$ ) across a cylindrical cathode ( $D \sim 8 \text{ cm}$ ) with a hole ( $d \sim 3 \text{ cm}$ ) and a copper anode ( $D \sim 11 \text{ cm}$ ) from a  $0.2 \mu\text{F}$  capacitor or a  $2.0 \mu\text{F}$  capacitor. Copper, graphite, aluminum and stainless steel cathodes were used in the experiment. The current was switched by a TGI 1-25000/35 thyatron commutator. Measurements of plasma concentration  $n$ , plasma mobility  $u$ , voltage  $V(t)$ , current  $I(t, n)$  and electric field intensity  $E(t, z)$  ( $t$  - time,  $z$  - longitudinal coordinate) were made with capacitive probes. High-frequency radiation from the plasma was recorded with loop and horn antennas. Evaluation and theoretical interpretation of the results reveal that two noncollective mechanisms which are diverse in time govern the evolution of instability under given conditions. Electron emission by the cold cathode governs the initial stage, and ion regeneration in the interelectrode space follows buildup of emission with attendant unbalancing of the number of charged particles and limitation of the discharge current. Localization of the electric field at the site of current limiting manifests the noncollectivity of this latter mechanism. Figures 7, references 23: 18 Russian, 5 Western. [206-2415]

## MEASUREMENT OF OPTICAL THICKNESS OF PLASMA AT SECOND HARMONIC IN L-2 STELLARATOR

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 1 Oct 82, after correction 16 Feb 83) pp 126-134

SUVOROV, Ye. V., FEDYANIN, O. I., FRAYMAN, A. A. and KHOL'NOV, Yu. V., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The optical thickness of plasma has already been measured at the electron cyclotron frequency of the ordinary wave and at the second-harmonic frequency of the extraordinary wave, with the optical thickness in the second

case being proportional to the electron pressure. Experimental plasma probing with linearly polarized radiation at the second cyclotron harmonic has also been done, in an L-2 stellarator. In this study the characteristics of radiation after passing through the plasma column in a stellarator are calculated theoretically and a new method of measurements is proposed. The calculations are based on expressions for the electric field components in a cartesian coordinate system and the polarization coefficient for the extraordinary wave, which yield all Stokes parameters of the transmitted radiation for any arbitrary polarization of the incident radiation. Important special cases are linear polarization transversely (x) or parallel (y) to the plasma column, linear polarization diagonally in the (xy) plane, and elliptical polarization of the ordinary wave or the extraordinary wave. The experimental method of determining the optical thickness involves measuring the resultant intensity  $I = I_x + I_y = E_x E_x^* + E_y E_y^*$  of the transmitted signal ( $E, E^*$  - components of electric field and their complex conjugates). The equipment consists of a backward-wave traveling-wave tube oscillator as source of microwave power at 4 mm wavelength, a rectangular-to-circular waveguide adapter, a vacuum spacer, a horn-lens transmitter antenna with fused quartz lens, a horn-lens receiver antenna with teflon lens, quasi-optics, a one-dimensional grating with 100  $\mu\text{m}$  period for wave splitting, and a set of two microwave detectors in quadrature. Measurements were made of radiation intensity and optical thickness as functions of time over a transient period of 30-40  $\mu\text{s}$ , of attenuation coefficient and optical thickness as function of the resonance-point coordinate, of Thomson scattering and also at electron concentration  $n_e$  yielding the radial distributions of electron temperature  $T_e$  and pressure  $nT_e$ . The results agree closely with those based on theoretical calculations. Figures 9, references 11: 6 Russian, 5 Western.

[206-2415]

UDC 533.951.8

#### INSTABILITY OF MAGNETOACOUSTIC OSCILLATIONS IN OPEN TRAPS

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 12 Aug 82, after correction 4 Nov 82) pp 66-68

ZVONKOV, A. V. and TIMOFEYEV, A. V., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] An array of ambipolar open plasma traps is considered where magnetoacoustic oscillations can build up in the outer traps, while the plasma in the center trap with equilibrium velocity distribution acts as mirror. The instability increment is calculated from the dispersion equation for magnetoacoustic oscillations in a homogeneous plasma, including the response to a transverse electric field rotating to the ion side and to the electron side. Both "conical" and "anisotropic" instabilities at harmonic multiples of the ion cyclotron frequency are considered, with the effect of Coulomb collisions on the velocity distribution of ions being taken into account. The derived relations reveal that the stabilizing effect of the magnetic mirror becomes stronger with rising plasma pressure and with decreasing magnetic field gradient, even an instability decrement resulting under sufficiently favorable conditions. References 7: 2 Russian, 5 Western.

[206-2415]

DEVELOPMENT DYNAMICS OF ION-ACOUSTIC TURBULENCE IN MAGNETICALLY ACTIVE PLASMA DURING INDUCED  $\omega$ -SCATTERING NEAR LOWER HYBRID RESONANCE

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 25 Nov 82) pp 41-49

KATANOV, G. M., KOLIK, L. V., SAPOZHNIKOV, A. V., SARKASYAN, K. A. and SKVORTSOVA, N. N., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] An experimental study was done on ion-acoustic waves in a magnetically active plasma, specifically on their development from the initial superthermal level upon pumping by a pulse wave near the lower hybrid resonance. A stationary cylindrical plasma column, 4 cm in diameter and 100 cm long, was produced by ionization of argon under pressures of  $(2-8) \cdot 10^{-4}$  torr with a low-energy 60-120 eV electron beam in a uniform 600 Oe magnetic field. The plasma concentration varied over the  $(2-4) \cdot 10^{10}$  cm $^{-3}$  range, and the electron temperature varied over the 3-6 eV range, with the ratio of electron temperature to ion temperature remaining  $T_e/T_i \approx 10$ . A pumping wave with a frequency of 24 MHz was produced with two semicylindrical plates enveloping the plasma column, with ion-acoustic turbulence in the plasma being produced by the drift current. The conditions of the experiment were such as to satisfy the inequality  $\omega_{Gi} \ll \omega_{LH} \approx \omega_{Li} < \omega_0 \ll \omega_{Le} \leq \omega_{Ge}$  ( $\omega_{Gi}, \omega_{Ge}$  - ion and electron Larmor frequencies;  $\omega_{Li}, \omega_{Le}$  - ion and electron Langmuir frequencies;  $\omega_{LH}$  - lower hybrid frequency). The turbulence spectra were measured with three narrow band amplifiers (0.4-0.7 MHz, 0.70-1.2 MHz, 2-3 MHz), one wideband amplified (0.4-5 MHz), and appropriate filters. Low-frequency oscillations were recorded on an oscillograph, the square of their amplitude being proportional to the spectra density of ion-concentration fluctuation energy, and their relation to high-frequency oscillations was explored by probing of the red satellite (19-23.5 MHz). Such measurements yielded information about thresholds and saturation of ion-acoustic turbulence, their dependence on the pumping field intensity, on the evolution of the turbulence spectrum in time, and on the increments of the oscillation amplitude at various individual frequencies. These increments, corresponding to buildup of instability, were found to occur initially in a linear manner  $dA/dt = \gamma A$  and then in a nonlinear  $dA/dt = \gamma A - \frac{A}{A_{sat}} A^{n+1}$ . The results confirm the hypothesis of induced  $\omega$ -scattering of oblique Langmuir pumping waves and the hypothesis of induced scattering of acoustic waves by ions, the latter scattering providing the nonlinear mechanisms which limits the buildup of ion-acoustic turbulence noise. They also reveal that high-frequency waves near the pumping frequency are excited by different mechanisms. The authors thank M. S. Rabinovich [deceased] for his interest in this study, L. M. Kovrizhnykh for valuable comments on the results, and G. P. Dergachev for technical assistance in the experiments. Figures 7, table 1, references 5 Russian.

[206-2415]



## ION-ACOUSTIC TURBULENCE AND TRANSPORT PROCESSES IN PLASMA IN STRONG ELECTRIC FIELD

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 25 Nov 82, after correction 1 Feb 83) pp 33-40

BYCHENKOV, V. Yu., GRADOV, O. M. and SILIN, V. P., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Ion-acoustic turbulence in plasma is analyzed on the basis of the angular distribution of fluctuations at high values of the corresponding Knudsen number. This distribution is determined from model equations that simultaneously account for quasi-linear relaxation of electrons and nonlinear induced scattering of waves, whereupon the total energy of ion-acoustic noise is also calculated. From that distribution of ion-acoustic turbulence are then determined the electron-kinetic coefficients, for establishment of the corresponding Ohm's law as well as for calculation of the electron thermal flux and the electron-temperature relaxation time. The results reveal an anisotropic charge transport during development of ion-acoustic turbulence and explain the anomalous decrease of the electrical resistance of a turbulized plasma with increasing electric field intensity. In strong electric fields the maximum intensity of ion-acoustic turbulence noise has been found to occur at a  $36^\circ$  angle to the vector of the effective force acting on electrons and causing instability. Figures 3, references 20: 15 Russian, 5 Western.  
[206-2415]

## PRODUCTION OF DENSE PLASMA COLUMN IN STRONG MAGNETIC FIELDS AND ITS DIAGNOSIS BY LASER METHODS

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 20 May 82) pp 175-182

ARZHANNIKOV, A. V., BURMASOV, V. S., VYACHESLAVOV, L. N. and KOYDAN, V. S., Institute of Atomic Physics, Siberian Department, USSR Academy of Sciences

[Abstract] An experimental study was done to demonstrate the feasibility of producing a plasma column with electron concentrations of up to  $10^{16} \text{ cm}^{-3}$  by means of a high-current Penning discharge and of diagnosing it on the basis of interaction with a laser beam. A discharge in a hydrogen atmosphere under a pressure of  $10^{-3}$ - $10^{-1}$  torr was produced with a voltage of 20-60 kV from a 1.6  $\mu\text{F}$  capacitor bank in a magnetic field of intensity up to 25 kOe. The discharge current was oscillatory, with period of 10  $\mu\text{s}$  and amplitude of 60 kA, total decay time not exceeding 80  $\mu\text{s}$ . The plasma was diagnosed by the scattering method with INAR equipment, to provide information about the plasma electron distribution and the effect of heating by an intense relativistic electron beam. The instrumentation included a ruby laser with Q-switching



by a Kerr cell as source of probing pulses of 15 J energy and 30 ns duration, two Michelson interferometers, two foil electrodes and one ring electrode, an interference filter with a passband of 80 Å about the 0.6943 μm center wavelength for suppressing the intrinsic plasma radiation, a set of diaphragms, a discharge chamber, two 8-channel photon scattering intensity and spectrum analyzers with an MDR-2 monochromator and one 4-channel low-angle (8°) radiation scattering analyzer. Measurements with the interferometers were made using a CO<sub>2</sub>-laser ( $\lambda = 10.6 \mu\text{m}$ ) as well as an LG-126 commercial He-Ne laser ( $\lambda = 33.9, 1.5, 0.63 \mu\text{m}$ ). Measurements yielded fairly accurate and reliable radial plasma profiles in the infrared region of the spectrum. The authors thank V. A. Rastropov and V. F. Zharov for assistance in the experiments, and V. V. Konyukhov and A. G. Makarov for developing and debugging the multichannel laser scattering equipment. Figures 7, references 11: 7 Russian, 4 Western.  
[206-2415]

UDC 533.951

#### PLASMA-BEAM INSTABILITY OF BOUNDED ELECTRON BEAM IN WEAK MAGNETIC FIELD

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 13 Jul 82, after correction 9 Dec 82) pp 106-111

IVANOV, A. A. and POPKOV, N. G., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] Plasma-beam instability of a space-bounded electron beam in a magnetic field is analyzed, assuming a weak magnetic field and an electron cyclotron frequency much lower than the oscillation frequency of plasma electrons. The fundamental Poisson equation, equation of continuity and equations of motion in a three-dimensional cartesian coordinate system are solved for potential oscillations of plasma electrons with concentration  $n_0$  and an electron beam passing through the plasma at velocity  $V$  in the direction of one of the coordinate axes. The electron beam is assumed to be "hot", and perturbations of the beam distribution in a self-consistent field are described by the Boltzmann equation. Integration of the perturbation function along trajectories with respect to velocity components, following the Fourier transform with respect to space coordinates, yields a simple criterion for plasma-beam instability that does not include the initial width of the perturbing wave packet. Further calculations yield the dependence of the plasma-beam instability on the magnetic field intensity, indicating that compensating the hyper-linear buildup of instability in a magnetic field of increasing strength is possible only by decreasing the thermal dispersion of the relaxing electron beam. As the magnetic field intensity increases, therefore, the electron beam will relax quasi-linearly to a smaller  $v_T/V$  ratio. The beam relaxation can thus be improved by lowering the magnetic field intensity. The authors thank A. B. Miklaylovskiy for valuable comments and kind critique, and O. N. Azarova for interest in the study and fruitful discussions. Figure 1, references 5 Russian.  
[206-2415]

# MAGNETOHYDRODYNAMIC STABILITY OF TOROIDAL SYSTEMS WITH AXIALLY NONUNIFORM MAGNETIC FIELD

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 3 Aug 82, after correction 31 Jan 83) pp 83-91

MIKHAYLOVSKIY, A. B., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] A closed toroidal system of the "Dracon" kind is considered with an axially nonuniform magnetic field, as planned in the International Tokamak Reactor. Such a system constitutes a hybrid of toroidal and mirror traps. The analysis of such a system in this study is based on the use of the metric g-mode tensor in a system of coordinates with round magnetic surfaces and "straightened" lines of force, with the longitudinal magnetic flux rather than the cross-sectional radius being used as the surface coordinate. The corresponding equations of equilibrium are solved for the establishment of MHD stability criteria. The method of analysis is also applicable to space-periodic systems with short axial period such as corrugated systems. The magnetic well is calculated using averages of the metric coefficients with  $\sqrt{g}$  as weight factor. First the Mercier criterion is extended to a system without longitudinal current and then to a tokamak with corrugation, the latter being found to have a destabilizing effect. The g-mode stability criterion is derived from the general one  $W - A_2 > 0$ , and here too corrugation is found to have a destabilizing effect. Both criteria are valid only when  $rn/R < Q$ . The authors thank V. M. Glagolev, B. A. Trubnikov, V. D. Shafranov for stimulating discussions, and S. V. Makurin for assistance. References 15: 7 Russian, 8 Western. [206-2415]

UDC 533.951.7

# NONLINEAR ABSORPTION OF EXTRAORDINARY WAVE BY PLASMA WITHIN RANGE OF UPPER HYBRID RESONANCE

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 16 Nov 82, after correction 1 Apr 83) pp 21-32

ANDREYEV, N. Ye., SERGEYEV, A. M. and STENCHIKOV, G. L., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The problem of absorption dynamics during interaction of a plasma and an extraordinary wave within the range of the upper hybrid resonance is solved for a magnetically active plasma and high-intensity microwave radiation. A uniformly nonhomogeneous plasma layer with one-dimensionally varying concentration distribution  $N(x,t)$  is considered in a constant magnetic field  $H_0(0,0,x)$  normal to the plasma concentration gradient and varying only along the same coordinate as the plasma concentration. The corresponding Maxwell equations, averaged with respect to the frequency of an incident electric microwave field, are solved for a propagating TM-mode. Numerical calculations

have yielded the distribution kinetics of longitudinal and transverse electric field components as well as the plasma concentration profile, also the fluctuating and nonlinear transient increase of the reflection coefficient to a "plateau" at levels that increase with increasing incident energy flux intensity and with decreasing longitudinal nonuniformity of the external magnetic field. The results are applicable to the study of controlled thermonuclear fusion in a tokamak with supplementary heating by injection of microwave radiation either from the inside of the plasma torus on the strong-magnetic-field side or from the outside of the plasma torus at the optimum angle. Figures 4, references 8: 5 Russian, 3 Western.  
[206-2415]

UDC 533.951

#### SCALAR MODEL OF LANGMUIR COLLAPSE

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 20 Sep 82) pp 9-20

DEGTYAREV, L. M. and KOPA-OVDIYENKO, A. P., Institute of Applied Mathematics imeni M. V. Keldysh, USSR Academy of Sciences

[Abstract] Boundless amplitude buildup and collapse of Langmuir waves in a plasma are analyzed on the basis of a scalar dynamic model, beginning with Langmuir oscillations in a collisionless plasma. A self-adjoint solution to the corresponding system of equations of ion-gas dynamics is obtained in the "supersonic" approximation, assuming that the electric field of the waves has slowly varying potential. The transient-state equations for the electric field of oscillations, in the Lagrange formalism of gas dynamics, have been solved analytically and numerically so as to yield profiles of the oscillation group velocity along the radial Euler coordinate at various instants of time and the Euler radial coordinate bounding the oscillation energy during compression as function of time for various values of the energy coordinate. An evaluation of the self-conjugate component of the total solution, the other component being regular, reveals a core with finite oscillation energy surrounded by a subsonic shell and contracting into a point while the intermediate zone between them is accelerated toward the center. The authors thank V. Ye. Zakharov and L. N. Shchur for fruitful discussions. Figures 5, table 1, references 23: 18 Russian, 5 Western.  
[206-2415]

## MODEL OF PLASMA EQUILIBRIUM IN TOKAMAK

Moscow AVTOMATIKA I TELEMEXHANIKA in Russian No 3, Mar 84 (manuscript received 26 Jun 83) pp 66-76

MITRISHKIN, Yu. V. and SAVKINA, I. S.

[Abstract] The subject model is constructed in order to investigate the possibility of controlling the plasma column over a wide range by varying the vertical magnetic field created by the current in the control windings. The model is approximated by a low-order dynamic section in order to synthesize and analyze a closed system for controlling plasma equilibrium. A method is presented for testing the initial system of differential equations by means of single-step inputs. The iterative approximation procedure converges to a limit that determines the approximation accuracy in the functional metric spaces of the discontinuous inputs and continuous outputs. The system was modeled at the Institute of Control Problems on an ICL-470 computer. Figures 7, references 10: 9 Russian, 1 Western.  
[264-6900]

UDC 533.9:536.24:537.53

## HEAT TRANSFER BY RADIATION IN HYDROGEN PLASMA

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 45, No 6, Dec 83 (manuscript received 14 Jun 82) pp 977-983

KOVAL'SKAYA, G. A., SEVAST'YANENKO, V. G. and SOLOUKHIN, R. I., Institute of Theoretical and Applied Mechanics, Siberian Department, USSR Academy of Sciences

[Abstract] Tables of partial intensities  $I$  (or  $S_{0m}$ ) and  $S_{1m}$  are presented for calculating the flux fields and the flux diversion fields in systems of any geometric form and with arbitrary pressure and temperature distribution. Radiation characteristics are calculated for heat transfer in systems containing hot hydrogen with arbitrary pressure distribution ranging from 0.1 to 30 bar and temperature ranging from room temperature to 20,000 K. Figures 4, references 20: 13 Russian, 7 Western.



UDC 531.383

DIFFERENTIAL EQUATIONS FOR MOVEMENT OF TRIAXIAL GYROSCOPIC STABILIZER ON MOVING BASE

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKhanIKA, ASTRONOMIYA in Russian No 1, Jan 84 (manuscript received 8 Apr 82) pp 59-63

ANTONCHIK, V. S. and ROMANYUK, I. I.

[Abstract] The triaxial gyroscope stabilizer is used in ships, aircraft etc. for determining the three angles of rotation around the center of inertia and for stabilization relative to the inertial space of the platform. Three two-degree gyroscopes are installed on a stabilizer platform suspended on universal-joint rings. Utilizing Lagrange equations, a complete set of differential equations is developed for gyroscope stabilizer motion on the moving base taking into account the inertial forces of the ring suspension, elastic deformation of gyroscope elements and the non-alignment of the centers of inertia of the platform and gyroscopes. Unlike earlier work, the equation system fully covers the forces of interaction between unit elements, and differentiation gives the required motion data. Figures 2, references 2 Russian.

[164-12497]

UDC 621.372.8.001.24

NUMERICAL INVESTIGATION OF EFFECT OF ANOMALOUSLY SMALL ATTENUATION OF ELECTRIC WAVES IN FLAT RIDGE WAVEGUIDE

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 3 FIZIKA ASTRONOMIYA in Russian Vol 24, No 4, Jul-Aug 83 (manuscript received 16 Nov 82) pp 55-57

MODENOV, V. P. and MAGATAYEV, A. V.

[Abstract] It has been observed experimentally that ridge waveguides have anomalously small attenuation for some types of normal waves, and numerical computations have been made on computers for rectangular corrugated waveguides as well as analytical studies on  $E_{0n}$  and  $H_{0n}$  waves. The paper concerns a computer treatment testing the analytic study of the attenuation of electric waves in flat ridge waveguide based upon impedance-type boundary conditions



and a dispersion formula for transverse complex wave numbers that was simplified by Newton's iteration method and led to the derivation of a formula giving the desired imaginary parts for the complex numbers. Computations then showed that, while losses for flat-walled waveguides increased, the further the effective frequency was from cut-off, there was a frequency range for ridge waveguides with anomalously low attenuation thus confirming earlier studies. The Brillouin concept may supply a physical interpretation. Figures 2, references 8: 5 Russian, 3 Western.  
[165-12497]

#### CONSTRUCTION OF THEORY OF MONOMODE LASER RADIATION FOR DICKE-TYPE MODULE SYSTEMS

Moscow TEORETICHESKAYA MATEMATICHESKAYA FIZIKA in Russian Vol 58, No 1, Jan 84 (manuscript received 24 Mar 83) pp 109-120

BALABANYAN, G. O., Moscow Institute of Electronic Machine Building

[Abstract] The dynamics of monomode laser radiation is investigated for different Dicke-type model systems on the basis of asymptotically exact (in the sense of the limiting thermodynamic transition) equations. The theory of multi-mode laser radiation is discussed in light of the findings. The requirement that laser models be gradient-invariant and that Dicke-type models must also be gradient-invariant is demonstrated. The approach employed can be used to explain continuous lasing, as well as the initial stage of pulsed lasing. Figures 2, references 26: 19 Russian, 7 Western.  
[191-6900]

#### STATISTICAL PROPERTIES OF RADIATION DURING NONLINEAR RESONANCE DIFFRACTION

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 85, No 6(12), Dec 83 (manuscript received 4 May 83) pp 2152-2158

SMIRNOV, D. F. and TROSHIN, A. S., Leningrad State Pedagogical Institute imeni A. I. Gertsen

[Abstract] Phonon antigrouping is demonstrated to be possible in the diffraction cone of a wave during nonlinear resonance scattering of an intense monochromatic light wave by a system of  $N$  two-level atoms. A photocurrent correlator and its spectrum are investigated, as is the variance in the number of samples. The trend toward antigrouping in another version of experimentation--heterodyning--is discussed. The possibility of distinguishing between normal and anomalous field correlators is considered. References 22: 15 Russian, 7 Western.  
[189-6900]

## ANALYSIS OF SPACE-TIME DISTRIBUTION OF CHARGED PARTICLES IN VOLUME GAS DISCHARGES

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 24, No 3, Mar 84 (manuscript received 3 Feb 82) pp 428-434

KOTEROV, V. N.

[Abstract] The transient electrical processes occurring in the cathode layers of electroionization discharges is investigated by means of a difference scheme that models the law of conservation of the total charge, and its corollary, which indicates that the total current density is the sum of the densities of the conduction current and the bias current. A nitrogen plasma generator is modeled numerically. The results of the methodical calculations are presented. Figures 4, references 7: 6 Russian, 1 Western.  
[254-6900]

## THEORY OF PHOTOACOUSTIC SIGNAL FORMATION IN EXPERIMENTS WITH SOLID BODIES

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 3, 12 Feb 84 (manuscript received 12 Nov 83) pp 129-132

GUREVICH, S. B. and MURATIKOV, K. L., Physical-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] The influence of internal heat sources in solids on the results of the Gersho-Rosencwaig theory is investigated. In addition to the temperature distribution predicted by the Gersho-Rosencwaig theory, uniform modulation of the temperature caused by dilation phenomena also occurs in the photoacoustic chamber employed. The influence of dilation on pressure oscillation is strongest for "soft" photoacoustic chambers, and results in a smaller photoacoustic signal than that predicted by the Gersho-Rosencwaig theory. References 10: 4 Russian, 6 Western.  
[198-6900]

# FORMATION AND ABSORPTION OF ATMOSPHERE IN CAVITY DUE TO DIFFUSION OF GAS ABSORBED IN CAVITY WALLS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 275, No 2, Mar 84  
(manuscript received 12 Jul 83) pp 361-364

IGNATOV, V. A. and STAKHANOV, I. P., Moscow Institute of Fine Chemical  
Technology imeni M. V. Lomonosov

[Abstract] The kinetics of the recovery of an equilibrium gas atmosphere density in a cavity as the result of the release of gas from the walls, or absorption by the walls of excess gas, is analyzed. It is shown that the number of atoms on the boundary approaches a value of  $N=n_0$ , which is the same as the initial density and the density of the atoms within the wall, as  $t \rightarrow \infty$ . The density of the atmosphere is shown to approach its equilibrium value exponentially as  $\delta \rightarrow 0$ ; for finite  $\delta$ , part of the density relaxes significantly more slowly. As  $\delta \rightarrow 0$ , the coefficient of diffusion is so great that the concentration in the wall is able to equalize and differs little from  $N_0$  regardless of  $\tau$ . References 4 Russian.  
[262-6900]

UDC 624.131+532.215+534.22

# PROPAGATION OF NONLINEAR COMPRESSION PULSES THROUGH GRANULAR MEDIA

Novosibirsk ZHURNAL PRIKLADNOY MEKhanIKI I TEKHNIChESKOY FIZIKI in Russian  
No 5(141), Sep-Oct 83 (manuscript received 12 Apr 82) pp 136-148

NESTERENKO, V. F., Novosibirsk

[Abstract] Transient nonlinear perturbations and subsequent propagation of nonlinear compression pulses in a one-dimensional granular medium are analyzed on the basis of intergranular interaction in accordance with Hertz's law, this law being extendable from static to dynamic situations under three constraints: 1) the maximum stress reached at the center of a contact surface must not exceed the strength level; 2) the dimensions of a contact surface must be much smaller than the radii of curvature of individual grains; 3) the characteristic time of perturbation and propagation must be much shorter than the period of oscillations of an elastic spherical grain in the fundamental mode. These constraints limit the velocity of metal grains 2-10 mm in diameter to less than 10 m/s so that dissipation processes during the initial stage can be disregarded. The problem has been solved numerically for a single row of identical spherical grains and for one of spherical grains with randomly different radii, after reduction of the second-order differential equations of motion for spherical particles with arbitrary radii to a system of first-order differential and difference equations. Both anharmonic and long-wave approximations were considered, the problem being reducible to that of nonlinear oscillators with a small ratio of deformation to initial displacement

in the first case and to the Korteweg-de Vries equation in the second case. The behavior of the solution in the latter approximation with zero initial displacement is tested on the basis of analogy to the motion of particles in a potential field. Results have been obtained for several specific situations including: 1) row of grains free at both ends, with decay of initial perturbation; 2) collision of two unequal solitons, the one with smaller amplitude either opposing the other one or reaching the other one from behind; 3) motion of piston at constant velocity; 4) external force with ramp profile. The author thanks L. V. Ovsyannikov, A. A. Deribas, R. M. Garipov for discussing the results and V. V. Deyneko, L. N. Shcheglov, N. G. Annikov for assisting with numerical calculations. Figures 8, references 8: 4 Russian, 4 Western. [205-2415]

UDC 533.951

# THEORY OF BREAKDOWN IN COLLISIONAL GAS BY ELECTROMAGNETIC WAVE EXCITED DURING BETATRON OSCILLATIONS OF RELATIVISTIC ELECTRON BEAM

Moscow FIZIKA PLAZMY in Russian Vol 10, No 1, Jan-Feb 84 (manuscript received 2 Feb 83, after correction 5 May 83) pp 192-195

BLIOKH, Yu. P. and MUKHIN, V. V., Kharkov Institute of Engineering Physics, UkSSR Academy of Sciences

[Abstract] Plasma-beam breakdown of a neutral gas by a relativistic electron beam is analyzed on the basis of a theory according to which betatron oscillations in the intrinsic magnetic field of the current become unstable with respect to excitation of electromagnetic waves and electrons with acquired energy above the ionization level will ionize the gas. However, this electromagnetic instability of a relativistic electron beam is not related to the presence of a plasma so that it will build up at an arbitrarily low initial plasma concentration with hardly any sensitivity to plasma nonhomogeneity. This theory is applied to a gas with hydrodynamic instability. Assuming an electromagnetic wave at resonance with Doppler-shifted betatron oscillations and using a dispersion equation that describes interaction of such a wave with the electron beam, an expression is obtained for the instability increment that takes dissipation into account. This yields equations for the changes in energy and plasma concentration during the quasi-linear initial stage of instability buildup and then when the energy acquired by electrons appreciably exceeds their thermal energy. This procedure is followed for low and high collision frequencies, with both the resonance conditions and the wave dispersion being different in each case. The authors establish constraints on the parameters of a relativistic electron beam and a simple relation between the beam current and the ratio of mean transverse electron velocity to velocity of light. The authors thank Ya. B. Faynberg for fruitful discussions. References 5 Russian. [206-2415]



## VELOCITY OF DISPERSAL WAVEFRONT FOLLOWING GASODYNAMIC EXPLOSION OF AEROSOL IN LASER BEAM

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 11, No 1, Jan 84  
(manuscript received 15 Feb 83) pp 221-224

KOLOSOV, V. V. and KUZNIKOVSKIY, A. V., Institute of Atmospheric Optics,  
Siberian Department, USSR Academy of Sciences, Tomsk

[Abstract] The feasibility of dispersing fog by gasodynamic explosion of liquid drops is examined theoretically, considering that a real light wave passing through such a fog, and scattered by acoustic shock waves is approximately an N-wave. The corresponding equation of light propagation is formulated as an equation of intensity transfer  $\frac{\partial W}{\partial z} + \frac{1}{c} \frac{\partial W}{\partial t} = \alpha(z, t)W(z, t)$  ( $W$ -intensity,  $z$ -longitudinal coordinate,  $t$ -time,  $c$ -velocity of light,

-scattering coefficient) and solved for the velocity of the dispersal wavefront  $dW/dt$  of a square-wave light pulse of amplitude  $W_{\max}$  and duration  $t_p$ . Variation of the scattering coefficient is considered not only in time but also in space, along the radius of the light beam, and an acoustic shock wave is assumed to be a Rayleigh-Gans scatterer. Estimates on this basis for a  $CO_2$ -laser beam indicate that a radiation pulse of  $5 \cdot 10^8$  W/cm<sup>2</sup> intensity and  $10^{-7}$  s duration with a shorter than  $10^{-8}$  s rise time will disperse a fog with an optical density of up to  $\tau \approx 5$ , with the wavefront velocity in a fog with  $\tau \approx 3$  becoming equal to the velocity of light and decreasing as  $\tau$  increases with attendant lengthening of the characteristic time of drop expansion.

Figure 1, references 9 Russian.  
[166-2415]

UDC 531.53

## NON-INTEGRABILITY OF PLANAR OSCILLATION EQUATION FOR SATELLITE IN ELLIPTICAL ORBIT

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA, MEKHANIKA in Russian No 1, Jan-Feb 84 (manuscript received 20 Jan 82) pp 71-73

BUROV, A. A.

[Abstract] The author considers the equation of planar oscillations of a satellite in elliptical orbit:

$$(1 + e \cos v) \ddot{\delta} + n^2 \sin \delta = e(4 \sin v + 2\delta \sin v),$$

$$n^2 = 3(A - C)/B, \quad n > 0. \quad (1)$$

where  $e$  is orbital eccentricity,  $v$  is the true anomaly of the center of mass,  $A$ ,  $B$  and  $C$  are the principal central moments of inertia of the satellite. It is assumed that the principal axis of inertia corresponding to moment  $B$  is orthogonal to the plane of the elliptical orbit. Then  $\delta$  is twice the angle



between the principal axis of inertia corresponding to moment  $C$  and the direction from the attracting center to the center of mass. To study the problem of existence of a first integral of equation (1), the author converts to the Hamilton equations

$$\begin{aligned}\dot{\delta} &= p/(1+e \cos v)^2 - 2, \\ \dot{p} &= -(1+e \cos v)n^2 \sin \delta\end{aligned}\tag{2}$$

with hamiltonian

$$H = [p/(1+e \cos v) - 2(1+e \cos v)]^2/2 - (1+e \cos v)n^2 \cos \delta.\tag{3}$$

The absence of an analytical first integral  $F(p, \delta, v)$  that is  $2\pi$ -periodic relative to the variables  $\delta$  and  $v$  in system (2) is proved by using classical ideas of H. Poincare developed by V. V. Kozlov and forming the basis of methods proposed by S. L. Ziglin. References 5 Russian.  
[128-6610]

UDC 518.9

STABLE EQUILIBRIUM POINTS IN MIXED EXTENSIONS OF NON-COOPERATIVE GAMES

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKhanika, ASTRONOMIYA in Russian No 1, Jan 84 (manuscript received 10 Jun 82) pp 17-22

MALAFEYEV, O. A.

[Abstract] Continuous pay-off functions are considered in non-cooperative n-player games with compact metric strategy spaces, and it is proven deductively that, in every game involving mixed strategies with a finite number of equilibrium points, there is at least one stable equilibrium point. A new proof is given for the theorem of Glikhsberg et al about the existence of an equilibrium point by means of a theorem on a fixed point for single-valued but not many-valued transformations that simplifies approximation. The Glikhsberg theorem is generalized for the case of a pay-off function that is semi-continuous from above while, previously, equilibrium points had been considered only for finite games and games with unit interval strategy spaces. References 13: 11 Russian, 2 Western.  
[164-12497]

UDC 517.97

PROBLEM OF PURSUIT BY SEVERAL OBJECTS IN NONLINEAR DISCRETE GAMES

Baku DOKLADY AKADEMII NAUK AZERBAYDZHANSKOY SSR in Russian Vol 49, No 11, Nov 83 (manuscript received 29 Dec 81) pp 7-11

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[Abstract] Differential games involving the pursuit of a target by several pursuers under specified geometrical conditions are frequently studied as concerns proofs that such games have a finite character with possible endings. The present study considers the problem of formulating binding conditions under which a single target can be successfully pursued. The system state is determined by the movement of a vector in n-dimensional Euclidian space, and it is proven that from a certain original configuration it is possible to end pursuit in a finite number of moves provided the pursuit satisfies determined conditions. Two conditions that are considered sufficient are formulated. References 5 Russian.  
[169-12497]

USE OF LEAST-SQUARES METHOD TO PROCESS DATA FROM PHYSICAL EXPERIMENT

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 45, No 6, Dec 83  
(manuscript received 31 Jan 83) pp 1027

LITVINENKO, A. A.

[Abstract] Problems of obtaining reliable results when constructing experimental formulas by the least squares method is examined when the conditions for obtaining good results include the ability to select criteria properly and to minimize possible computational errors when computers are used.

References 1 Russian.

[172-6900]

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